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ABSTRACT

This instructor's guide contains the materials required to teach a competency-based introductory course in highway bridge construction to students who have chosen to explore careers in construction. The manual contains three units. Unit titles are: bridge materials, bridge tools, and applied skills. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for the instructor, extensions and options, information sheets, student supplements, transparency masters, instructional supplements, assignment sheets, job sheets, practical tests, written tests, and answers to assignment sheets and written tests. Academic skills training is combined with vocational training throughout the instructional materials, and a system of icons has been used to help instructors identify activities into which training in the following basic skill areas has been infused: reading, science, creative thinking/problem solving, writing, oral communication, employability, math, interpersonal skills, and social studies. Most units of instruction are designed for use in more than one lesson or class period of instruction. These materials precede the instructional units: information on basic skills in curriculum, information on measuring student performance gains, and required criteria for a competency-based education program. A competency profile and basic skills matrix are included. (YLB)

ED 385 694

introduction to construction series

introduction to highway bridge construction

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Introduction to Highway Bridge Construction

Developed as a Cooperative Project by
the Associated General Contractors of America
Steve L. Hoech, Chairman, Workforce Development Committee
and
Curriculum and Instructional Materials Center,

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Curriculum and Instructional Materials Center

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Introduction to Highway Bridge Construction

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FOREWORD

In 1985, The Associated General Contractors of America (AGC) met with representatives of the Oklahoma Curriculum and Instructional Materials Center (CIMC) to discuss the possibilities of developing, as a cooperative project a course of instruction designed for training individuals who choose to seriously explore careers in construction.

This publication is the result of those original discussions and updates made through close coordination among general contractors and vocational educators. This series represents conscious effort to coordinate the practical experience of personnel in the carpentry industry with the best instructional methods of those in the field of vocational education.

Although this book reflects a systematic approach to instructional materials development and the latest in educational technology innovations, the information in the *Introduction to Highway Bridge Construction* manual should be adapted and modified to coincide with local conditions.

Roy Peters, Jr.
State Director
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and Technical Education

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The Associated General Contractors
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PREFACE

Construction requires that students have many skills and related information to become productive workers in this challenging field. Workers must be better trained and equipped to find and retain meaningful employment.

Instructional materials in this manual is written in terms of student performance, using measurable behavioral learning process. Criterion-referenced evaluation instrument provide for a uniform measurement of student progress.

The purpose of this manual is to assist instructors in all construction related areas in providing instruction throughout the industry. Any information in this manual that does not concur with the instructor's course of study should be modified to meet personal needs.

Personnel safety is of prime concern, as an instructor you are encouraged to closely observe and couch students in all safety issues. We have done much to advise students of possible dangers, but your close supervision and alertness can't be overemphasized.

Al Willey
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational
and Technical Education

ACKNOWLEDGEMENTS

Much appreciation is expressed to the many individuals who contributed their time, talents, and knowledge in the revision of this manual.

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USE OF THIS PUBLICATION
INSTRUCTIONAL UNIT

Introduction to Highway Bridge Construction contains three units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for the instructor, extensions and options, information sheets, students supplements, transparency masters, instructional supplements, assignment sheets, job sheets, practical tests, written test, and answers to assignment sheets and written test, all of which are included in the instructor's edition. The student workbook includes the objective sheets, information sheets, student supplements, transparency masters, assignment sheets, and job sheets. Written tests may be duplicated for classroom use or *additional copies* may be purchased by calling 1-800-654-4502 or, in Oklahoma, 1-800-522-5810, ext. 589.

All of the unit components tie into measurable and observable learning outcomes. Instructors are encouraged to supplement these components with other resources in order to make them as responsive to local conditions and individual needs as possible.

Most units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the instructor will help him or her determine the following:

- Amount of material that can be covered in each class period.
- Skills that must be demonstrated.
  - — Supplies and equipment needed
  - — Amount of class time needed for demonstrations
  - — Amount of time needed for student practice
- Supplementary materials, including print and non-print media, that must be ordered.
- Resource people who must be contacted.

Objective Sheet

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms. The unit objectives states the overall goal of the unit. It tells what the student should be able to do and what standard will be used to see whether the student can do it. Specific objectives outline the teaching sequence of the competencies required to meet the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could be best taught.

Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the instructor should remember to supply the needed information, assignment and/or job sheets, and criterion-referenced test items.

Suggested Activities — Instructor's Edition only

The suggested activities page assists the instructor during the preparation stage of the teaching/learning process by providing suggestions for delivery, application, and evaluation during the instructional process. The instructor should read the suggested activities prior to introducing the unit to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the instructor will vary according to the particular unit.

References used in the development of each unit are listed in the "Suggested Resources" section, along with print and non-print media that may be used to teach the unit. These materials can be used by the instructor to supplement his or her knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Extensions and Options — Instructor's Edition only

Extensions and Options are supplemental material that is not testable or graded and is nice-to-know. Extensions and Options provide the instructor with additional activities, fact sheets, art, controversial items, and extra practice sheets. They may also include items for the gifted or remedial student. Extensions and Options are used at the discretion of the instructor.

Information Sheets

The information sheet provides "must know" content essential for meeting the cognitive objectives stated at the beginning of each unit. It serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheet before it is discussed in class. Space is provided in margins for students and instructors to add notes that clarify and/or expand on the information provided.

The information sheet may include notes, cautions, or warnings. These should be discussed carefully and thoroughly. **Notes** are short verbal additions to the information sheet or procedural outline that provide nice-to-know and decision-making information. A note may tell the student what to watch for or to consider at a given step. It may explain when a step may not be applicable. Notes offer guidance that may help the student understand the process and do it more efficiently. **Cautions** are advisories that tell the student how to avoid causing minor personal injury or equipment damage. **Warnings** are advisories to the student used to avoid serious personal injury or death to the student, persons in the workplace, or users of the project or the procedure.

Student Supplement

Student supplements include instructions that could be used for solving problems or reinforcing the enrichment of learning. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment or job sheets. While supplements are not tested over directly, they may be used to assist in meeting the performance objectives.

Transparency Masters — Instructor's Edition only

Transparency masters provide information in a special way. The students may see as well as hear the materials being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information or assignment sheets.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Instructional Supplements — Instructor's Edition only

Instructional Supplements provide suggestions for teaching the basic skills included in each assignment sheet or job sheet. They are located directly in front of the components they support—assignment or job sheets—in each unit.

Assignment Sheets

Assignment sheets provide students with information and exercises that address learning levels at or above the application level of Bloom's taxonomy. Assignment sheets provide written exercises for instruction and practice of a specific objective. The introduction to the assignment sheet explains how the assignment sheet relates to the subject area and unit component for such information.

Assignment Sheet Answers — Instructor's Edition only

This component is designed to assist the instructor in evaluating student performance on assignment sheets.

Job Sheet

Job Sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure to complete each task or job. Diagrams, photographs, and illustration are provided to assist students in achieving the skill.

The instructor should demonstrate the procedure outlined in each job sheet. Furthermore, the instructor needs to localize the procedure according to the equipment and supplies available in the local lab or salon situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Practical Tests — Instructor's Edition only

The practical tests are designed to assist the instructor in the evaluation of the psychomotor activities (job sheets). The practical test provides instructors with a valid mechanism for determining a student's level of ability in performing the procedure stated on the job sheet. The check-off list allows instructors to evaluate a student's process performance of the task on the job sheet. The overall competency indicator allows the instructor to evaluate the end product.

Written Test — Instructor's Edition only

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. If objectives have been added, deleted, or modified, appropriate changes should be made on the test.

In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *absolutely essential* that the same test be used as a pretest and as a posttest. If you choose to use tests other than the ones included herein, be sure that the same instrument is used for each activity—pre- and post test.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication, *Measuring Learning & Competency Gain: The Pretest/Posttest Approach.* This booklet and accompanying software designed to assist in calculating and recording student gains are available to all vocational teachers through the school's vocational testing liaison.

To further assist vocational teachers, the CIMC is in the process of developing test code sheets for each written test in its more recent publications, including this one. These code sheets are explained in Section 8 of the publication mentioned above, and will greatly assist in verifying that the test is a valid instrument for measuring student learning and competency gains.

Written Test Answers — Instructor's Edition only

This component is designed to assist the instructor in evaluating student performance on written tests.

COMPETENCY PROFILES

A competency profile is in the front of each publication. Competency profiles document student performance. The profile contains a list of the specific job competencies that a student should achieve before leaving the training program.

PAGE NUMBERING

Each publication for the Curriculum and Instructional Materials Center is usually assigned a specific abbreviation. ***Introduction to Highway Bridge Construction*** has not been abbreviated. Each unit will be recognized by the unit number in Arabic numerals. Each unit in the publication begins with page 1. Each page number gives the component name, Introduction to Highway Bridge Construction, unit number, and page number within the unit. Since some CIMC publications are loose-leaf, this system of page numbering was recently adopted so that pages from different manuals would not get mixed up. The page number for the objective sheet in *Introduction to Highway Bridge Construction*, which is Unit 2, would look like this:

OBJECTIVE SHEET - **Introduction to Highway Bridge Construction**
CIMC - A2 - 1

METHODS OF DISSEMINATING MATERIAL

For best results, provide student materials for each student. Student workbooks contain objective sheets, information sheets, supplements, transparency masters, assignment sheets, and job sheets. Pretest, practical tests, and written tests are packaged separately for students, and can be stored until needed. Students should be allowed to take their materials home at the end of the course.

TEACHING METHODS

Keeping students motivated is a challenge. Supplement the objectives by providing the "why," personal experiences, and current information. If you are going to teach the material in a group setting, prepare for the unit be deciding the best way to teach each objective and allow for student input.

If you are going to follow the plan for individualized instruction, provide opportunities that will allow each student to become involved in planning for and being responsible for his or her own education.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Coordinator of Development
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and
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1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

For a free catalog, a list of new publications, or other instructional materials information call 1-800-522-5810, extension 589.

RESALE

BASIC SKILLS IN CURRICULUM

The CIMC has always been mindful of the importance of reinforcement (and sometimes remediation) of students' academic skills as they progress through vocational training, and has always included activities in its materials to enhance and promote use of these skills.

Recent state and federal legislation mandates vigorous basic skills development in vocational education in the wake of demands by industry that workers *must* be academically, as well as technically, competent, given the nature of the highly complex work place. In response, the CIMC has taken the following steps to document that, indeed, the instructional materials *do* combine academic skills training with the vocational training. In addition, concerted efforts have been made to "beef up," or enhance the basic skills instruction already present. Following is a brief description of those processes:

Basic Skills Icons and Enablers

To assist teachers and students in identifying activities that promote basic skills development, the CIMC has implemented a marking system that uses simple graphic symbols, or icons, and a list of specific tasks, or enablers, to identify the basic skill or skills that are called for in each job or assignment sheet.

Each of the nine broad skills areas—reading, writing, mathematics, science, oral communication, interpersonal or relating, creative thinking and problem solving, employability, and social studies—is represented by the icon presented below.

Reading

Science

Creative Thinking/ Problem Solving

Writing

Oral Communication

Employability

Math

Interpersonal or Relating

Social Studies

When an activity involving one of these basic skills is identified, the corresponding icon is placed in the left-hand margin of the job or assignment sheet. The basic skills training is further defined by retrieving the specific, or enabling, skill that is required by consulting a list of over two hundred and fifty enablers that has been compiled and grouped with each general basic skill. This enabling skill is placed directly below the icon.

As an example, an exercise that requires a student to conduct library research would make necessary the use of specific reading comprehension and research and reference skills. The basic skills that the exercise promotes would be depicted in the left-hand margin as follows:

ASSIGNMENT SHEET | ***PLANNING LIVING SPACE FOR HUMAN NEEDS*** **1**

Name _____ Score _____

OBJECTIVE 10 **Define personal territory.**

INSTRUCTIONS

Reading Comprehension
- Gain factual information

Functional Reading
- Follow written instructions
- Use content area vocabulary

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

- As discussed in Objective 1, each person has an invisible "space bubble" or comfort zone. A comfort zone is the space between oneself and others that brings a feeling of well-being. When one's comfort zone is crowded or invaded, discomfort often results. Therefore, personal territory needs should be a prime consideration when planning living space.
- For each of the following situations, draw your estimated comfort zone around the figures provided.
- Indicate how many inches from your body the comfort zone extends.
- Consider how that comfort zone changes in different situations. Answer the questions that follow.

Basic Skills Documentation Matrix

Another component of the CIMC basic skills instructional plan is the "Basic Skills Documentation Matrix." The matrix graphically summarizes the basic skills training included in the vocational program, unit by unit. It should be helpful to teachers in planning their instruction, and to administrators as documentation that basic skills are being addressed during the vocational training.

The matrix for this publication is included as an 8½" by 11" foldout in this *Instructor's Manual.*

Matrices have been developed for most CIMC publications. For more information on those available for other programs, call the CIMC at 1-800-654-4502.

Instructional Supplement

The supplement is a tool for the instructor to use in helping students apply the basic skills in Assignment Sheets and Job Sheets. Some supplements are appropriate for use with all students; some are for use only with those students who do not understand the academic skills called for in the exercise.

MEASURING STUDENT PERFORMANCE GAINS

When you examine this book, you will notice that separate written pretests are no longer included in the units of instruction. Each CIMC unit now contains only a single Written Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	Discussion	CIMC component meeting criterion
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Written Test and Job Sheet/Skill Test

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet/Skill Test
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Competency Profile

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This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

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Page: Comment:

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1500 W. 7TH AVE
STILLWATER OK 74074-9907

OBJECTIVE SHEET	HIGHWAY BRIDGE MATERIALS	A 1

INTRODUCTION

Our transportation system requires the use of safe highway bridges. Modern bridges are required to support enormous weights and increasing volumes of traffic.

There are many types of bridge designs. This unit describes materials required to construct a steel reinforced concrete bridge.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student will be able to identify materials used to construct bridges. The student will demonstrate these competencies by completing the assignment sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to show the ability to:

1. Given a list of terms associated with highway bridge materials, match them to their correct definitions.
2. Given a list of terms associated with concrete materials, match them to their correct definitions.
3. Name common types and shapes of structural steel used in modern highway bridges.
4. Interpret reinforcing bar size markings.
5. Given illustrations, identify hardware accessories used to install reinforcing bars.
6. Given illustrations, identify parts of the common types of concrete forms used to construct highway bridges. (Assignment Sheet 1)

SUGGESTED ACTIVITIES	HIGHWAY BRIDGE MATERIALS	A 1

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with highway bridge materials, match them to their correct definitions.

- Use the Information Sheet to discuss the list of terms.
- Use catalogs to show pictures or drawings of materials.

Objective 2: Given a list of terms associated with concrete materials, match them to their correct definitions.

- Use the Information Sheet to discuss common concrete terms used in highway bridge construction.

Objective 3: Name common types and shapes of structural steel used in modern highway bridges.

- Explain that, based on the bridge plans, many shapes of structural steel can be used in bridges.
- Emphasize that the "I" beam and flat sheet are the most common shapes used in highway bridge construction.

Objective 4: Interpret reinforcing bar size markings.

- Explain rebar identification markings using the Information Sheets.
- Use Transparency 1 to supplement your discussion.
- Describe the importance of following the bridge specifications in the use of rebar. Ask the students to research magazines or newspapers that describe bridge failures and their causes.

Objective 5: Given illustrations, identify hardware accessories used to install reinforcing bars.

- Use the Information Sheet to discuss common hardware accessories.
- Emphasize the OSHA requirement to place caps over protruding rebar ends to protect personnel.

APPLICATION

Objective 6: Given illustrations, identify parts of the common types of concrete forms used to construct highway bridges. (Assignment Sheet 1)

- Use Transparencies 1 and 2 to supplement your discussion.
- Allow students to practice the procedures in the Assignment Sheet.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.
- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Electronic Media

- *Vertical Piers and Columns*

  This VHS video is available through the Oklahoma Department of Vocational and Technical Education or AGC of America, 1957 E. Street N.W., Washington, D.C., 20006.

UNIT REFERENCES

- Toenjes, Leonard P. *Building Trades Dictionary.* American Technical Publishers, Inc.: Homewood, IL, 1989.
- Willey, Al. *Commercial Carpentry.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education/Curriculum and Instructional materials Center and the Associated General Contractors of America, 1993.
- Willey, Al. *Introduction to Concrete Reinforcing.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and AGC of America, 1994.

INFORMATION SHEET	HIGHWAY BRIDGE MATERIALS	A 1

OBJECTIVE 1

Given a list of terms associated with highway bridge materials, match them to their correct definitions.

- Terms associated with general bridge building
  - **abutments** — the structures that support the ends of a bridge
  - **bent** — the framework placed at right angles to the length of a bridge; the combination of a column and cap make up a bent for a bridge.
  - **bridge deck** — the pavement surface of a bridge
  - **column or pier** — a vertical member designed to support a cross beam
  - **column clamp** — a manufactured device placed around column form to strengthen form against pressure exerted by wet concrete
  - **monolithic pour** — continuous mass of concrete cast as a single unit
  - **sheathing** — wide boards, plywood, or metal that make up the face of a form
  - **strap wrench** — a wrench used to tighten and hold band steel until it is secured
  - **strongback** — a temporary brace attached to back of forms to help support them
  - **template** — a device for holding bolts/reinforcing steel in place prior to concrete placement
  - **wedge** — a tapered piece of wood or metal

— **yoke** — a job-built device placed around a column form to strengthen the form against the pressure exerted by wet concrete

- Terms associated with concrete reinforcing and structural steel

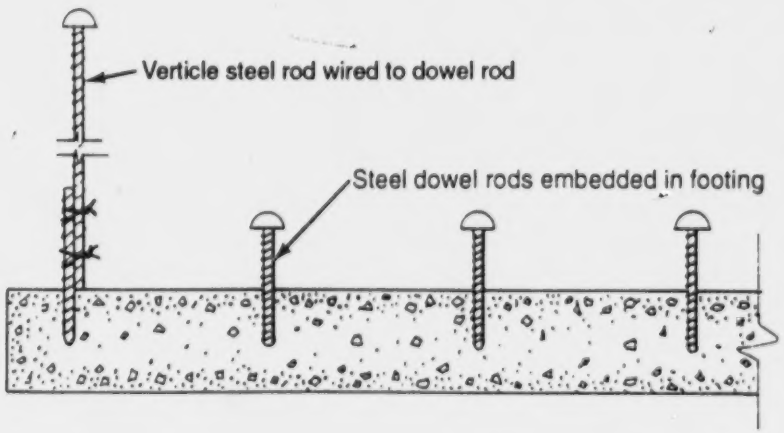
— **concrete coverage** — the distance at which reinforcing steel is embedded into the concrete. A minimum coverage is specified on the building plans

— **diameter** — the distance across a circular figure at its center point

— **double strong** — two thicknesses of tie wire

— **dowels** — reinforcing bars connecting two separately cast sections of concrete. These are also known as *stub rods.*

FIGURE 1



— **structural steel** — the load bearing steel members in a structure

— **fiber mesh reinforcement** — metal, nylon, or plastic strands added to concrete to improve its tensile strength

- **mat** — a grid of preassembled reinforcing bars
- **post-tension concrete** — use of steel wire or cable being located inside ducts embedded in concrete; Once the concrete hardens, the wires/cables are stretched tight to improve concrete strength.
- **precast concrete** — large sections of concrete that are poured and set in place with a crane after hardening
- **pre-tension concrete** — use of steel wire or cable being tightly stretched before the concrete is poured; once hardened, the tension is relaxed and results in stronger concrete.
- **PSI or psi** — pounds per square inch
- **rebar supports** — formed wire devices, used to support, hold and space reinforcing bars
- **reinforcing rod (rebar)** — deformed steel bar added to concrete to increase its tensile strength
- **tensile strength** — capacity for resisting a bending, stretching, or twisting force
- **wire ties** — a metal wire used to fasten reinforcing rods or wire fabric together

• Terms associated with bridge deck forms

- **bracket (hanger)** — a braced frame used to support deck overhang
- **bulkhead** — a board placed in a form to cut off or end the concrete pour
- **coil bolt** — a bolt with coarse threads made to fit the helix coil of coil ties and anchors
- **deck** — a horizontal sheathing that supports the wet concrete

— **diaphragm** — spacer beams placed at intervals on long girders

NOTE: The diaphragm is perpendicular to the long girders and also supports the concrete at construction joints in the slab.

— **drip groove** — a groove in any soffit where the undersurface is exposed to weather; designed to keep water from running back on the soffit

— **edge form** — a low form placed at the perimeter of a slab

— **median barrier** — a wall projecting from the deck dividing opposite lanes of traffic

— **needle beam** — a horizontal support members set on shores or hung

— **parapet** — the longitudinal wall above the surface of the deck which serves as an outside barrier along the length of a bridge

— **scab** — a piece of wood or metal secured across a joint to strengthen and hold the two pieces together

— **screed** — supports the finishing machine used to pour a bridge deck

— **scuppers** — a steel catch basin located on the low point of the bridge slab which is designed to drain water off the bridge slab

- General terms associated with bridge forms

— **beam bottom** — the horizontal part of a beam form

— **beam hanger** — a steel hanger that supports beam and slab forms

— **beam side** — the stud frame and sheathing section that comprise vertical section of a beam form

— **brace** — a piece of wood or other material that directs, resists, or supports weight or pressure

— **form oil** — the oil applied to the interior surface of formwork to facilitate removal of the forms

— **ledger** — a horizontal board nailed to a form to support intersecting horizontal members

— **soffit spacer** — a spacing device to provide proper concrete coverage under a beam

— **stringer** — a piece of material placed across several shores; a horizontal or inclined supporting member

OBJECTIVE 2

Given a list of terms associated with concrete materials, match them to their correct definitions.

- **admixture** — an agent added to concrete mix immediately before or during mixing to alter one or more concrete characteristic

  EXAMPLE: Pigments are mixed with concrete to change its color.

- **aggregate** — a granular material which makes up about 60 to 80 percent of the volume of concrete

  NOTE: Sand, gravel, and crushed stone are the most commonly used aggregates.

- **air entrainment** — entrapment of small air pockets in concrete; they help concrete resist the adverse effects of the freeze/thaw cycle.

- **anchor** — a metal device used to fasten structural members to concrete or masonry

- **bond** — to cause to stick together

- **bleeding** — the emergence of mixing water on the surface of newly placed concrete; caused by settling of solid materials within the mass

- **cement** — a powder made from alumina, silica, lime, iron oxide, and magnesia burned together in a kiln and finely pulverized; an ingredient in concrete

- **concrete** — a building material made by mixing cement, water, and aggregates

  NOTE: Fresh concrete is highly alkaline (caustic) and can cause skin irritation, eye infection, and in some cases severe skin burns. Always wear protective clothing and follow strict safety precautions when working with fresh concrete.

- **curing** — the process of hardening concrete

- **dermatitis** — a skin infection that can be caused by exposure to cement

- **form** — a structure or mold used to retain concrete until it hardens

- **hydration** — the chemical reaction of water with cement resulting in hardening

- **joint** — a seam used to control and/or prevent the amount of cracking in concrete or to allow movement of adjoining concrete masses

- **keyway** — a groove built into concrete structures to improve their ability to shift or move horizontally without cracking or overlapping

- **pigment** — admixture added to concrete to change its color

- **plasticity** — the capacity for being flexible or workable

- **retarding admixture** — an agent added to concrete to slow the curing process; used in hot weather to improve concrete strength

- **setting time** — time required for concrete to become firm or solid

- **slump test** — a test used to determine the consistency of concrete
- **slump** — the measure of consistency of freshly mixed concrete
- **workability** — ease with which concrete can be placed, consolidated, and finished

OBJECTIVE 3

Name common types and shapes of structural steel used in modern highway bridges.

- Round

FIGURE 2

- Channel

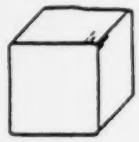
FIGURE 3

- H-beam or wide flange

FIGURE 4

- Square bar

FIGURE 5

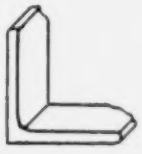


- I-beam

FIGURE 6

- Angle

FIGURE 7



- Tee

FIGURE 8

- Flat sheet

FIGURE 9

OBJECTIVE 4 **Interpret reinforcing bar size markings.**

- Markings to identify rebar diameter or size

  NOTE: Diameters are designated by numbers, each number denotes ⅛ inch. As an example, a #4 bar is 4 × ⅛" or ½" in diameter. Smaller diameter bars are rolled into lengths up to 60 feet.

  — #4 — ½" rod diameter"

FIGURE 10

OBJECTIVE 5

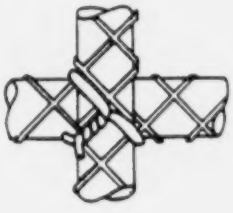
Given illustrations, identify hardware accessories used to install reinforcing bars.

- Wire ties

NOTE: 16 gauge, black annealed wire or wire pigtails are used to make the ties below. Although it may be difficult to see below, each tie end is twisted 3 to 4 twists.

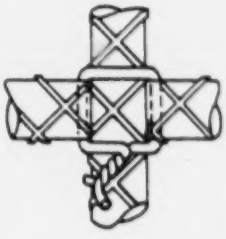
— Single tie (snaptie)

FIGURE 11



— Saddle tie

FIGURE 12



— Tie wire

FIGURE 13

— Wire tie (pigtail)

FIGURE 14

- Miscellaneous

  — Rebar caps

FIGURE 15

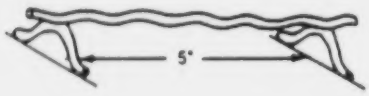
NOTE: Rebar caps must be placed over any protruding rebar ends to protect personnel (an OSHA requirement) from injuries.

- Types of rebar supports and their symbols

NOTE: Rebar supports are used to ensure rebar is held in the proper position that ensures the specified concrete coverage.

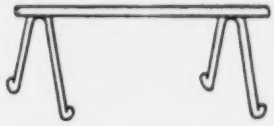
— Slab bolster (SB) — used to support the bottom mat of rebar

FIGURE 16



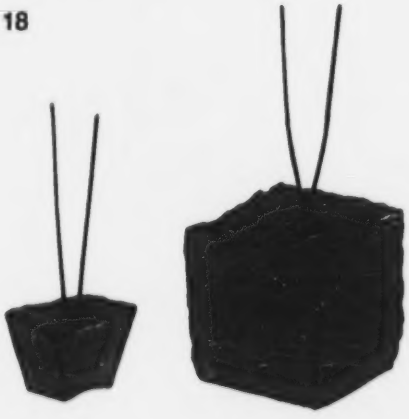
— Continuous high chair (CHC)

FIGURE 17



— Wired dobies

FIGURE 18



NOTE: Epoxy coating on reinforcing steel and tie wires is required in many areas to inhibit deterioration.

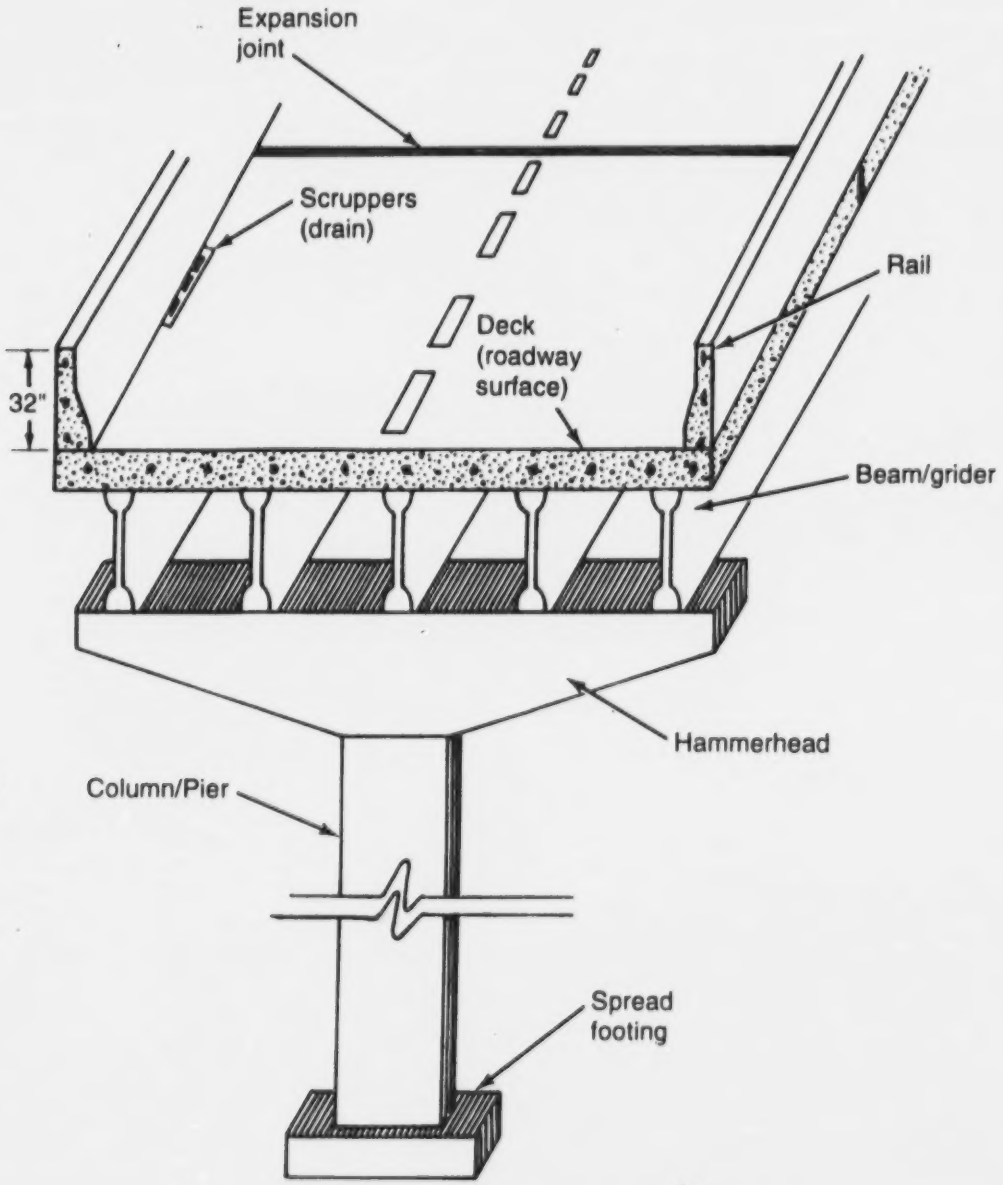
OBJECTIVE 7

Given illustrations, identify parts of the common types of forms used to construct highway bridges. (Assignment Sheet 2)

INTRODUCTION

The basic parts of a typical highway bridge include:

FIGURE 19



- Highway bridge form parts
  - — Column/pier form parts
    - A. Column clamp
    - B. Wood yoke

FIGURE 20

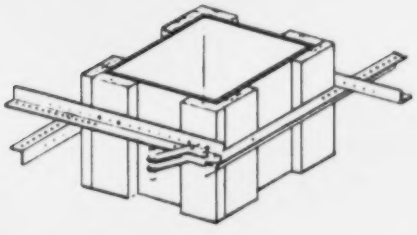
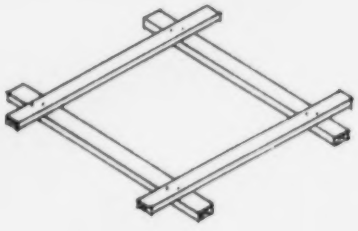


FIGURE 21



C. Manufactured metal, fiber, or molded fiberglass forms

D. Combination wood and metal

FIGURE 22

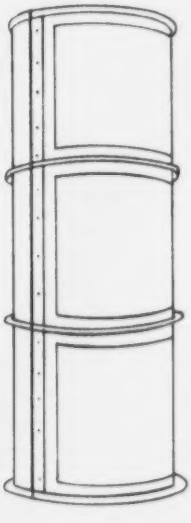
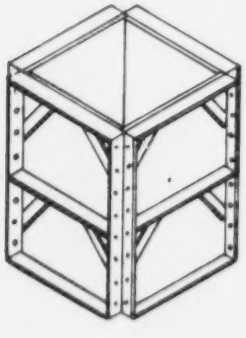


FIGURE 23

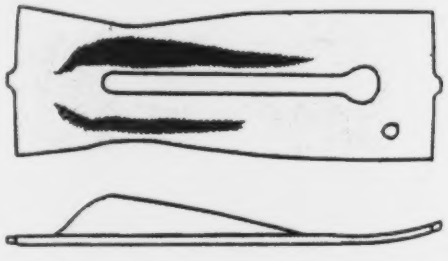


- Form ties and clamps
  - — she-bolt assembly

FIGURE 24

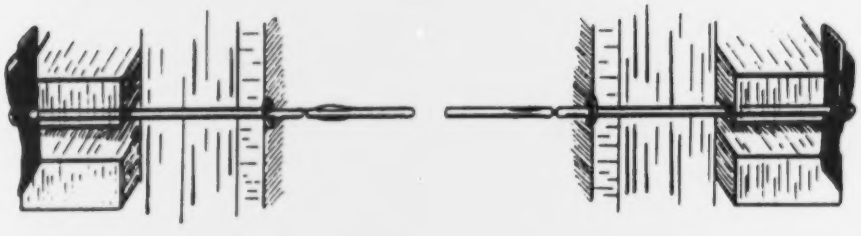
- wall-tie clamp

FIGURE 25



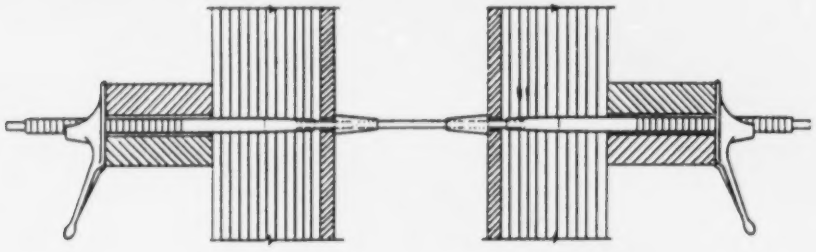
- wall-tie assembly

FIGURE 26



- threaded-rod wall-tie assembly

FIGURE 27



- coil tie with spreader cone

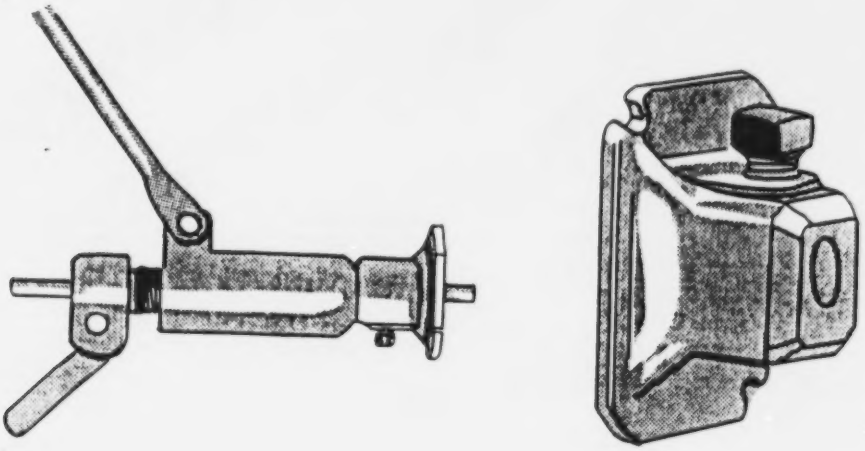
FIGURE 28

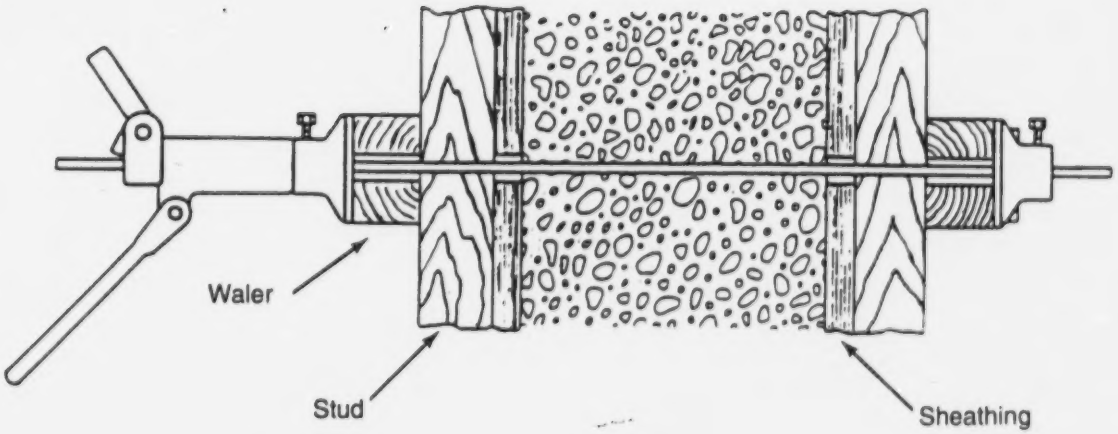
- coil tie with separate spreader

FIGURE 29

- form clamps (buttons) used with plain, round, mild-steel rods

FIGURE 30

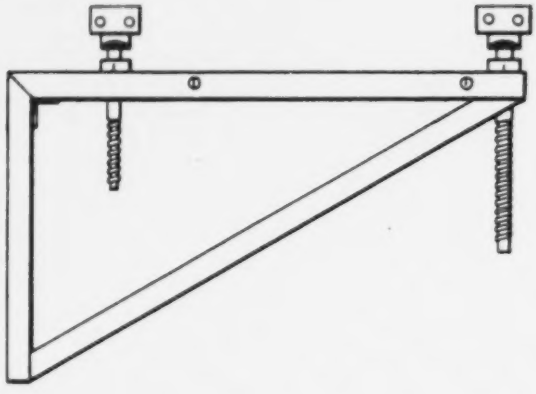




- Miscellaneous form parts

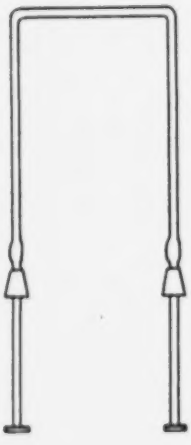
  — Overhang jack

FIGURE 31



  — Steel hanger

FIGURE 32



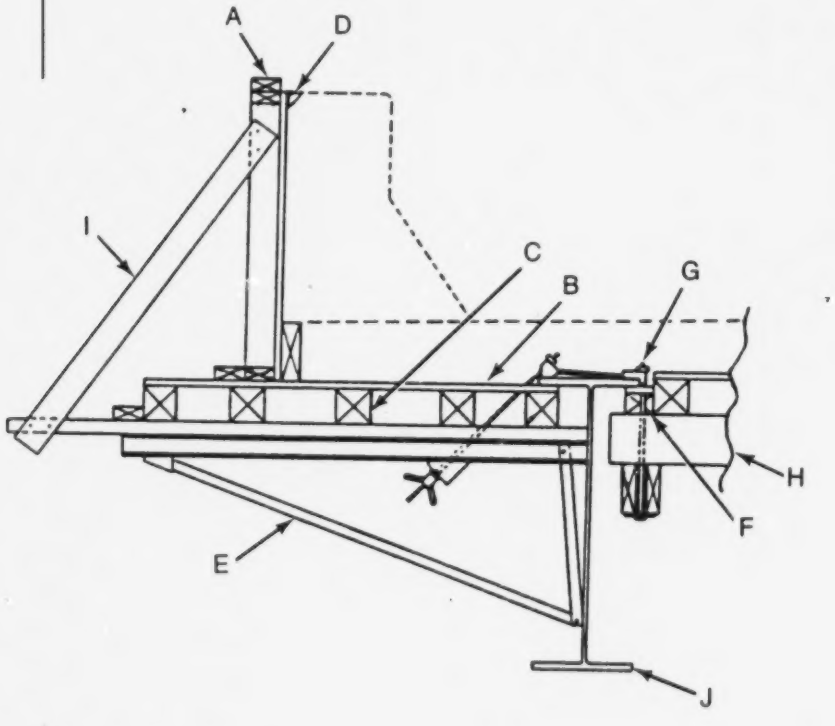
NOTE: Used to support deck forms.

- Bridge deck form parts

  — Overhang brackets used with a steel beam and deck form

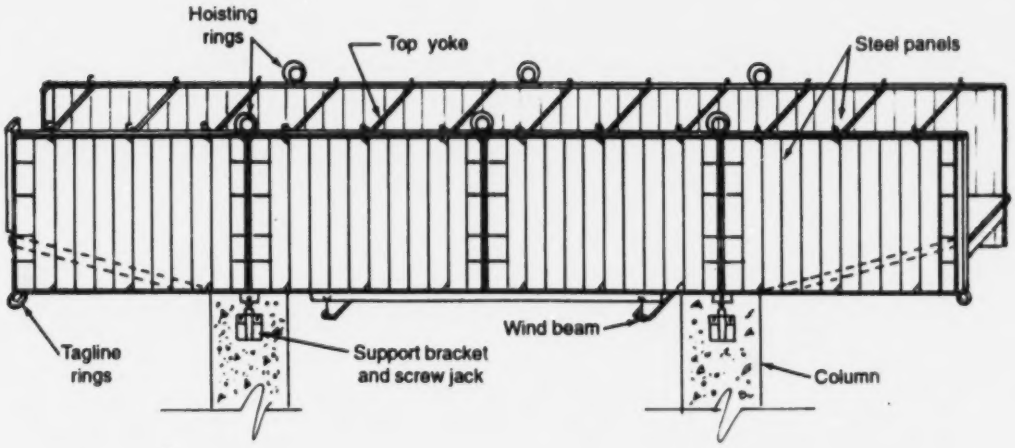
A. Edge form
B. Plywood decking
C. Joist
D. Chamfer
E. Overhead jack bracket
F. Wood blocking
G. Steel hanger
H. Stringer
I. Brace
J. Steel beam

FIGURE 33



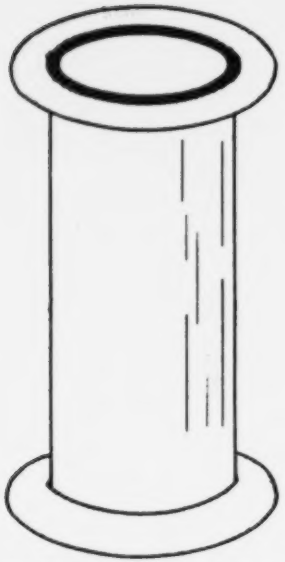
- Bridge forms (patented form) for bridge cap
  - — Plate girder form (Figure 34)

FIGURE 34



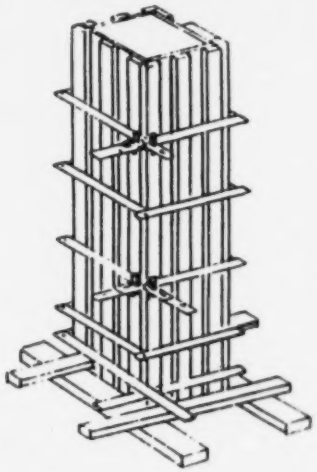
NOTE: Plate girder forms are made of steel panels that are assembled at ground level and hoisted into position with a crane.

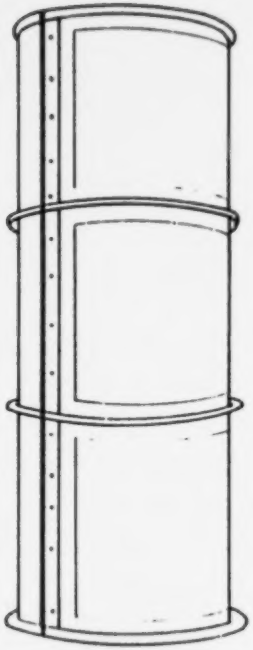
Materials Used For Column Forms



MOLDED FIBERGLASS

PLYWOOD





STEEL

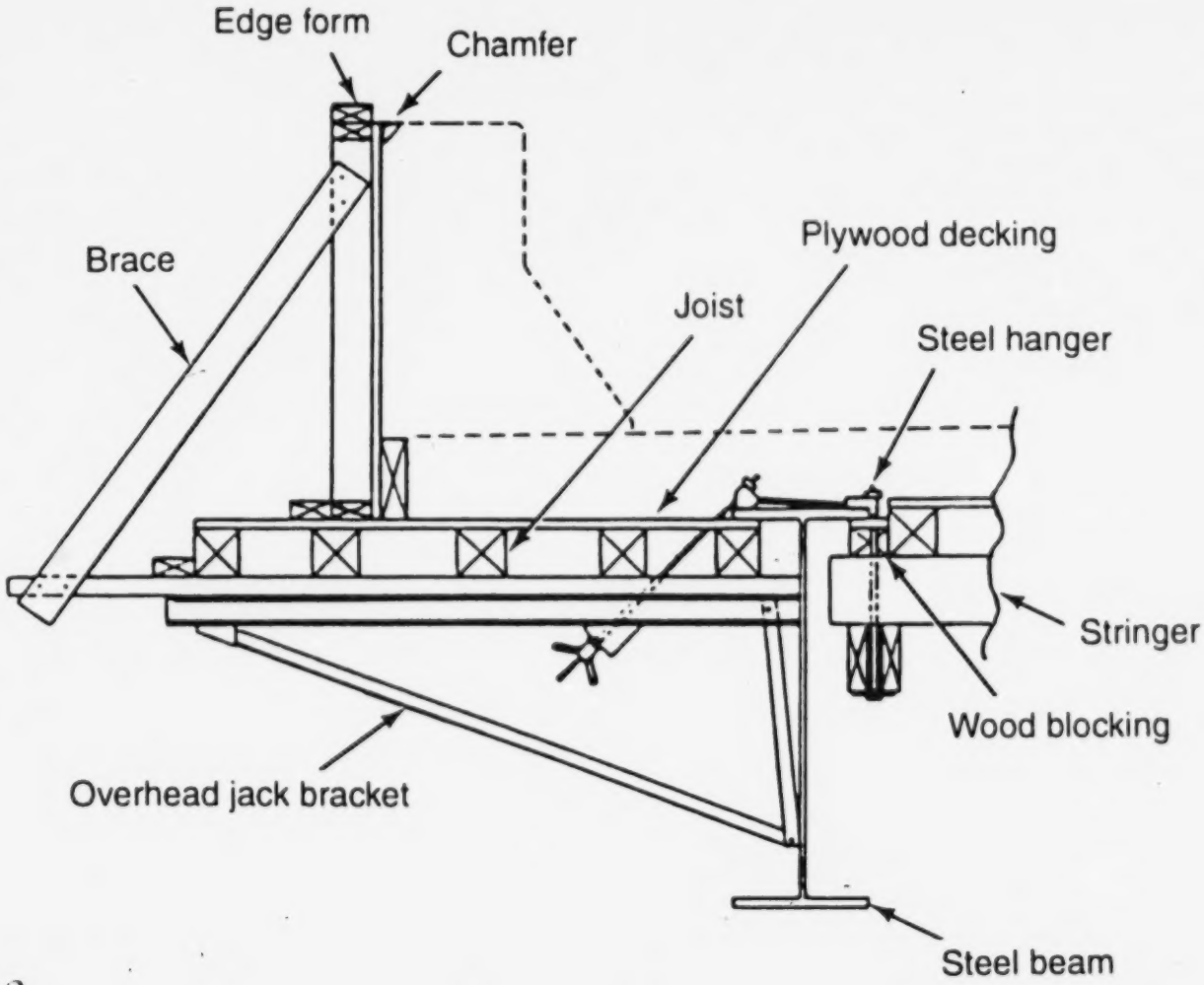
FIBER (PAPER)

TRANSPARENCY MASTER 1 - Intro to Highway Bridge Construction
CIMC - A 1 - 27

votech

TM 1

Parts of a Bridge Deck Form



ASSIGNMENT SHEET 1	HIGHWAY BRIDGE MATERIALS	A 1

Name _____ Score _____

OBJECTIVE 7

Given illustrations, identify parts of the common types of forms used to construct highway bridges.

INTRODUCTION

This exercise will allow you to practice the identification of form parts used to construct highway bridges.

INSTRUCTIONS

Write the correct numbers in the blanks

Part A: Deck form

_____a. Brace

_____b. Edge form (parapet)

_____c. Plywood decking

_____d. Wood blocking

_____e. Stringer

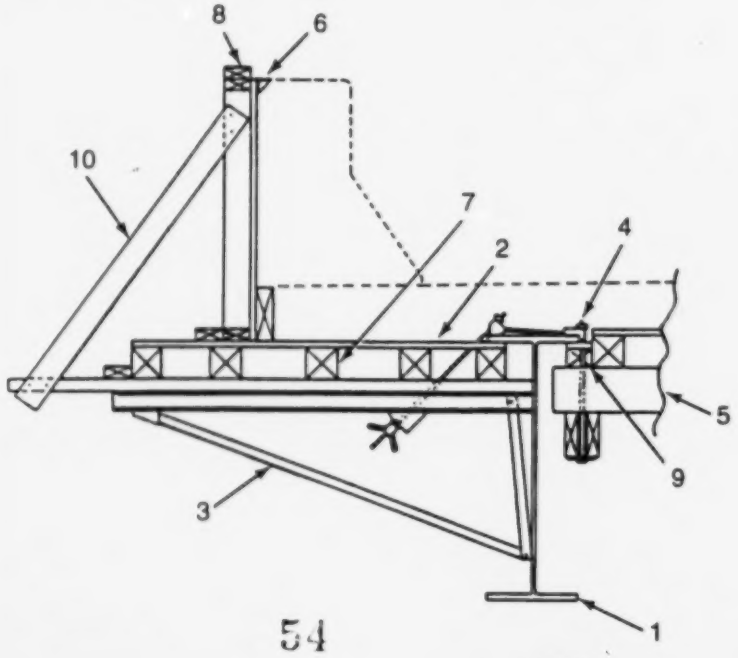
_____f. Joist

_____g. Steel hanger

_____h. Chamfer

_____i. Overhang jack bracket

_____j. Steel beam



Part B: Plate girder form

_____a. Column

_____b. Top yoke

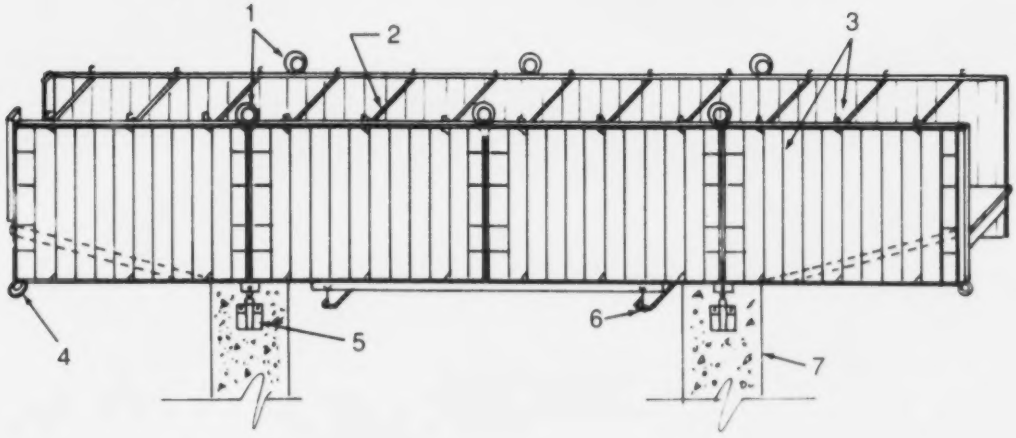
_____c. Wind beam

_____d. Tagline ring

_____e. Support bracket and screw jack

_____f. Steel panels

_____g. Hoisting rings



ASSIGNMENT SHEET 1

Part A

a.	10	f.	7
b.	8	g.	4
c.	2	h.	6
d.	9	i.	3
e.	5	j.	1

Part B

a.	7	e.	5
b.	2	f.	3
c.	6	g.	1
d.	4		

WRITTEN TEST

HIGHWAY BRIDGE MATERIALS A 1

Name _____ Score _____

OBJECTIVE 1

Given a list of terms associated with highway bridge materials, match them to their correct definitions. Write the letter that corresponds to the most correct answer.

_____ 1. The nylon or plastic strands added to concrete to improve its tensile strength are called

a. wire fabric
b. steel formed concrete
c. fiber mesh reinforcement
d. pigment admixture

_____ 2. The capacity of concrete to resist a bending, stretching, or twisting force is known as its

a. tensile strength
b. texture transfer
c. bonding capacity
d. hardness rating

_____ 3. The distance across a circular figure at its center point is known as its

a. circumference
b. radius
c. diameter
d. chord ring

_____ 4. Two thicknesses of tie wire is known as

a. double strong
b. dual loops
c. over-looped
d. thick-tie

May be photocopied for student use.

votech

_____ 5. The framework placed at right angles to the length of a bridge is called a/an

a. abutment
b. bridge deck
c. column
d. bent

_____ 6. The structures that support the ends of a bridge are called

a. parapets
b. abutments
c. needle beams
d. diaphragms

_____ 7. Deformed steel bars added to concrete to increase its tensile strength are

a. welded wire fabric
b. reinforcing fiber
c. deformed wire
d. reinforcing bars (rebar)

_____ 8. A composition of cement, aggregate, and water is

a. billet
b. concrete
c. mortar aggregate
d. both a and b are correct

_____ 9. Formed wire devices, used to support, hold, and space reinforcing bars are known as

a. wire fabric
b. jack support
c. pigtails
d. rebar supports

May be photocopied for student use.

votech

_____10. Metal wire used to fasten reinforcing rods or wire fabric together is called

a. wire ties
b. rebar loops
c. cradles
d. clip rings

_____11. A manufactured device placed around a column form to strengthen the form against pressure exerted by wet concrete is a

a. column clamp
b. pier bond
c. staves
d. template

_____12. Wide boards, plywood, or metal that makes up the face of a form is called

a. templates
b. yokes
c. dowels
d. sheathing

_____13. The pavement surface of a bridge is the

a. abutment
b. bridge deck
c. parapet
d. pad

_____14. A job-built device placed around a column form to strengthen form against pressure exerted by wet concrete is

a. wedge
b. yoke
c. collar
d. capital

May be photocopied for student use.

_____15. A vertical member designed to support a cross beam is a

a. column or pier
b. beam
c. billet or rail
d. ledger

_____16. Temporary brace attached to back of the forms to help support them is known as a

a. strongback
b. yoke
c. wedge
d. stringer

_____17. A device to support the finishing machine when pouring a bridge deck is a

a. rake-off
b. screed
c. ledger
d. stringer

_____18. A groove in any soffit where the undersurface is exposed to weather; designed to keep water from running back on the soffit is a

a. parapet
b. diaphragm
c. scuppers
d. drip groove

_____19. Longitudinal walk above the surface of the deck which serves as an outside barrier along the length of a bridge is the

a. bulkhead
b. headwall
c. ledger
d. parapet

May be photocopied for student use.

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_____20. A device for holding bolts/reinforcing steel in place prior to concrete placement is a

a. yoke
b. capital
c. template
d. mat

_____21. Braced frame used to support deck overhang is a

a. bracket (hanger)
b. coil bolt
c. diaphragm
d. soffit hanger

_____22. A bolt with coarse threads made to fit the helix coil of coil ties and anchors is a

a. diaphragm bolt
b. coil bolt
c. helix deck bolt
d. ledger bolt

_____23. Horizontal support members set on shores or hung are known as a

a. stringer
b. monolithic member
c. needle beam
d. screed beam

_____24. A continuous mass of concrete cast as a single unit is a

a. slab on grade
b. monolithic pour
c. screed
d. median mass

May be photocopied for student use.

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_____25. A steel hanger that supports beam and slab forms is a

a. ledger hanger
b. beam hanger
c. soffit hanger
d. "I" beam support

OBJECTIVE 2

Given a list of terms associated with concrete materials, match them to their correct definitions.

_____ 1. A building material made by mixing cement, water, and aggregates is

a. admixture
b. bonding
c. concrete
d. slump

_____ 2. The time required for concrete to become firm or solid is

a. slump time
b. setting time
c. hydration
d. workability

_____ 3. The measure of consistency of freshly mixed concrete is

a. slump
b. plasticity
c. curing
d. workability

____ 4. A skin infection that can be caused by exposure to cement is

a. hydration
b. dermatitis
c. demo-rash
d. aggregated skin

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_____ 5. A granular material which makes up about 60 to 80 percent of the volume of concrete is

a. cement
b. alkaline
c. slump
d. aggregate

_____ 6. The emergence of mixing water on the surface of newly place concrete, caused by settling of solid materials within the mass, is

a. hydration
b. sweating
c. slump
d. bleeding

_____ 7. The entrapment of small air pockets in concrete which help concrete resist the adverse effects of the freeze/thaw cycle is

a. air entrainment
b. entrapment
c. hydration
d. bonding

_____ 8. What is an agent added to concrete to slow the curing process, used in hot weather to improve concrete strength?

a. Water
b. slump agent
c. Retarding agent
d. Alkaline

_____ 9. A chemical reaction of water with cement resulting in hardening is

a. plasticity
b. hydration
c. workability
d. bleeding

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_____10. What is a seam used to control and/or prevent the amount of cracking in concrete or to allow movement of adjoining concrete masses?

a. Plasticity seam
b. Joint
c. Keyway
d. Shift bar

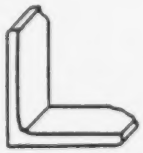
OBJECTIVE 3

Name common types and shapes of structural steel used in modern highway bridges.

_____1. The steel shape shown below is a/an

a. "T" beam
b. rail
c. "I" beam
d. angle

_____2. This steel shape is called a/an



a. "L" bar
b. rebar
c. side angle
d. angle

May be photocopied for student use.

votech

_____3. The steel shape illustrated below is a/an

a. "C" bar
b. echo bar
c. channel
d. angle

OBJECTIVE 4

Interpret reinforcing bar size markings. Use the illustration to respond to the question below.

_____ 1. The size of the bar shown above is

a. 10″
b. 8″
c. 4″
d. 1¼″

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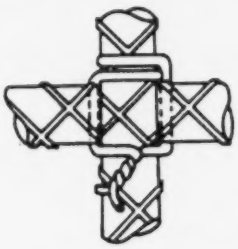
OBJECTIVE 5

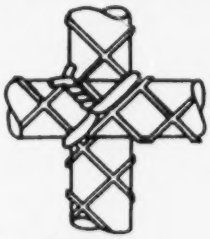
Given illustrations, identify hardware accessories used to install reinforcing bars.

_____ 1. This figure represents a



a. single tie
b. double loop tie
c. saddle tie
d. cross-hitch tie

_____ 2. Connecting rebar as shown below uses a/an



a. loop tie
b. cross tie
c. single tie
d. over-hand tie

_____ 3. The title of this hardware accessory is a

a. pigtail
b. wire loop
c. ring lock
d. simple splice wire

May be photocopied for student use.

_____ 4. This accessory is a

a. support cap
b. rebar cap
c. hub splice
d. rain cap

NOTE: Objective 6 is evaluated on an assignment sheet in this unit. If you have not completed this component, see your instructor.

May be photocopied for student use.

WRITTEN TEST ANSWERS	HIGHWAY BRIDGE MATERIALS	A 1

OBJECTIVE 1

1. c	8. b	15. a	22. b
2. a	9. d	16. a	23. c
3. c	10. a	17. b	24. b
4. a	11. a	18. d	25. b
5. d	12. d	19. d	
6. b	13. b	20. c	
7. d	14. b	21. a	

OBJECTIVE 2

1. c	6. d
2. b	7. a
3. a	8. c
4. b	9. b
5. d	10. b

OBJECTIVE 3

1. c
2. d
3. c

OBJECTIVE 4

1. d

OBJECTIVE 5

1. c	3. a
2. c	4. b

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) ***Introduction to Highway Bridge Construction***

UNIT NUMBER AND TITLE — A 1 Highway Bridge Materials

TOTAL NUMBER OF TEST QUESTIONS 43

TOTAL NUMBER OF BASIC SKILL QUESTIONS 1

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-25	X
2	1-10	X
3	1-3	X
4	1	M
5	1-4	X
6	Evaluated on AS	

OBJECTIVE SHEET	HIGHWAY BRIDGE TOOLS	A 2

INTRODUCTION

There are hundreds of tools and equipment types used in the construction of bridges. This unit will provide you the knowledge to identify those most commonly used. It will also allow you to practice skills to safely use selected tools through step-by-step instructions.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student will be able to identify common tools and safely use them. The student will demonstrate these competencies by completing the assignment sheets, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to show the ability to:

1. Given a list of terms associated with highway bridge construction tools, match them to their correct definitions.
2. From alternatives, choose the proper care and safety guidelines for the use of hand and power tools.
3. Given drawings, match ladders and scaffold types to their identities.
4. Use an illustration to identify the parts of a scaffold.
5. Choose from alternatives, the proper safety rules for the use of ladders and scaffolds.
6. Given drawings, identify hand tools used for the construction of highway bridges. (Assignment Sheet 1)
7. Given drawings, identify power tools and equipment used for the construction of highway bridges. (Assignment Sheet 2)

8. Use a hammer properly. (Job Sheet 1)
9. Use a handsaw. (Job Sheet 2)
10. Use a level. (Job Sheet 3)
11. Perform a crosscut using a radial arm saw. (Job Sheet 4)

SUGGESTED ACTIVITIES	HIGHWAY BRIDGE TOOLS	A 2

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with highway bridge construction tools, match them to their correct definitions.

- Show students examples to illustrate appropriate terms.
- Use the Information Sheet to discuss terms.

Objective 2: From alternatives, choose the proper care and safety guidelines for the use of hand and power tools.

- Discuss guidelines for the safe use of tools.
- Describe incidents you may have experienced in which improper care and use of tools caused injuries or accidents.

Objective 3: Given drawings, match ladders and scaffold types to their identities.

- Show the video *Success at the Top: Stairway and Ladder Safety.*
- Use catalogs to show drawings or pictures of ladders and scaffolds.

Objective 4: Use an illustration to identify the parts of a scaffold.

- Use Transparency 1 to supplement your discussion.
- Explain that there are several vendors of scaffolds. Terminology may be slightly different between vendors.

Objective 5: Choose from alternatives, the proper safety rules for the use of ladders and scaffolds.

- Show the VHS film *Working Safely on Scaffolds.*
- Use Transparencies 2 and 3 to supplement your discussion.
- Explain the importance of following OSHA rules and regulations when using scaffolds and ladders.

Objective 6: Given drawings, identify hand tools used for the construction of highway bridges. (Assignment Sheet 1)
Objective 7: Given drawings, identify power tools and equipment used for the construction of highway bridges. (Assignment Sheet 2)
Objective 8: Use a hammer properly. (Job Sheet 1)
Objective 9: Use a handsaw. (Job Sheet 2)
Objective 10: Use a level. (Job Sheet 3)
Objective 11: Perform a crosscut using a radial arm saw. (Job Sheet 4)

- Allow students to practice the procedures in the Job Sheets.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.

- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.
- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Electronic Media

- *Success at the Top: Stairway and Ladder Safety*, VHS, 16 min.
- *Working Safely on Scaffolds*, VHS, 10 min.

  These videos are available from the Oklahoma Department of Vocational and Technical Education or AGC of America, 1957 E. Street N.W., Washington, D.C. 20006.

UNIT REFERENCES

- Toenjes Leonard P. *Building Trades Dictionary*. American Technical Publishers, Inc.: Homewood, IL 60430.
- Willey, Al. *Introduction to Carpentry*. Stillwater, OK: Oklahoma Department of Vocational and Technical Education/Curriculum and Instructional Materials Center; and The Associated General Contractors of America. 1994.

- Willey, Al. *Commercial Carpentry*. Stillwater, OK: Oklahoma Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America. 1993.

INFORMATION SHEET	HIGHWAY BRIDGE TOOLS	A 2

OBJECTIVE 1

Given a list of terms associated with highway bridge construction tools, match them to their correct definitions.

- **arbor** — on an electric tool, the rotating shaft or bar that holds cutting tools
- **booster** — the powder load used to project fasteners in powder-actuated tools
- **drive pin** — the fastener used in a powder-actuated tool
- **ground** — electrical connection between a piece of equipment and another conducting object or surface, such as the earth, that provides an easy path for electricity to flow if a short occurs
- **ground fault circuit interruption (GFCI)** — special circuits used to protect workers from electrical shock when using AC powered tools and equipment
- **kerf** — the narrow groove produced by a saw blade

  NOTE: "Kerf" can also mean a small cut equal to the width of the blade used for holding line or for decoration.
- **kickback** — the sharp, violent reaction of a tool as it rejects material being forced into it
- **miter** — a cut made at an angle for joining two pieces of material so that they will form an angle
- **miter box** — a device used to guide a saw at the proper angle for cutting a miter joint
- **plumb bob** — a tool or device attached to a string; used to set and check for the vertical of a surface
- **push stick** — a safety device used to push material through cutters to protect fingers from being cut

- **relief cut** — a cut in stock that keeps blade from binding
- **soapstone** — soft stone having a soapy feel; used for marking metal and masonry
- **try square** — an instrument for marking and checking angles
- **tying tool** — a tool used to install pigtails

OBJECTIVE 2

From alternatives, choose the proper care and safety guidelines for the use of hand and power tools.

- General Safety Guidelines
  - — Do not attempt to operate any power tool before being checked out by your instructor or supervisor for that particular tool.
  - — Always wear eye protection and a hard hat when operating all power tools.
  - — Wear face protection when necessary.
  - — Remove jewelry (necklaces, watches, rings)
  - — Wear appropriate clothing for job being done.

    NOTE: Always wear tight-fitting clothing that cannot get caught in the moving tool. Roll up long sleeves, tuck in shirttails, and tie back long hair.
  - — Do not distract others or let anyone distract you while operating a power tool.
  - — Do not engage in horseplay in the shop or at the job site.
  - — Do not run or throw objects in the shop or at the job site.
  - — Consider the safety of others as well as yourself.
  - — Do not leave a power tool running while unattended.

- Assume a safe and comfortable position before using a power tool.
- Be sure that a power tool is properly grounded before using it. Use a GFCI or assured grounding method for all power tools and equipment at the construction site. The circuit must be installed at the power source.
- Be sure that a power tool is disconnected before performing maintenance or changing accessories.
- Do not use a dull or broken tool or accessories.
- Use a power tool only for its intended use.
- Keep your feet, fingers, and hair away from the blade and/or other moving parts of a power tool.
- Do not use a power tool with guards or safety devices removed.
- Do not operate a power tool if your hands or feet are wet.
- Keep work area clean at all times.
- Use electric extension cords of sufficient size to service the particular power tool you are using.
- Report unsafe conditions to your instructor or supervisor.

• General Guidelines for Power Tool Care

- Keep tools clean and in good working order.
- Keep machine surfaces clean and waxed.
- Follow the manufacturer's maintenance procedures.
- Protect cutting edges.
- Keep all tool accessories, such as blades and bits, sharp.
- Always use the appropriate blade for the arbor size.

— Report any unusual noises, sounds, or vibrations to your instructor or supervisor.

— Inspect tools and accessories regularly.

— Keep tools in their proper place when not in use.

— Use the proper blade for the job being done.

OBJECTIVE 3 **Given drawings, match ladders and scaffold types to their identities.**

- Ladders

  Ladders may be wood, metal, or fiberglass. Maintain caution when using metal ladders near any electrical wires or equipment.

1. Stepladder
2. Extension
3. Single, straight

FIGURE 1

FIGURE 2

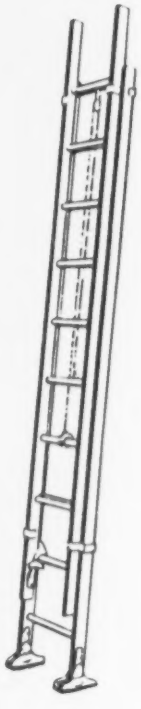
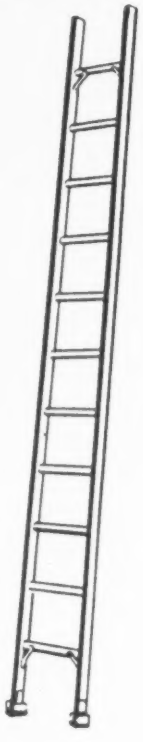


FIGURE 3



Ladders are classified by their weight handling capacity or working load. The chart below is one ladder manufacturer's specifications for each ladder type.

TYPE	DUTY RATING	WORKING LOAD
Type III Type II	Household Commercial	200 lbs. 225 lbs.
Type I Type IA	Heavy Duty Ex. Heavy Duty	250 lbs. 300 lbs.

NOTE: Be sure to consider the ladder working load specifications when purchasing or using ladders.

- Scaffolds

Scaffolds may be wood, steel, or aluminum; they may be prefabricated or built at the job site.

— Prefabricated

FIGURE 4

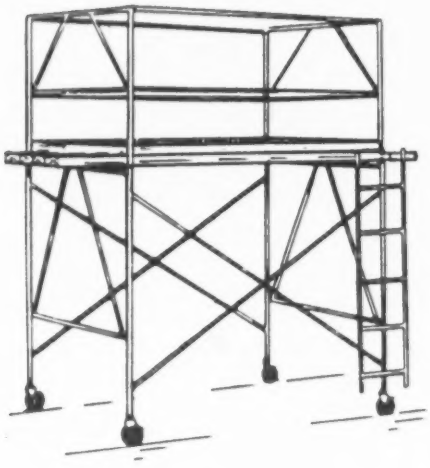
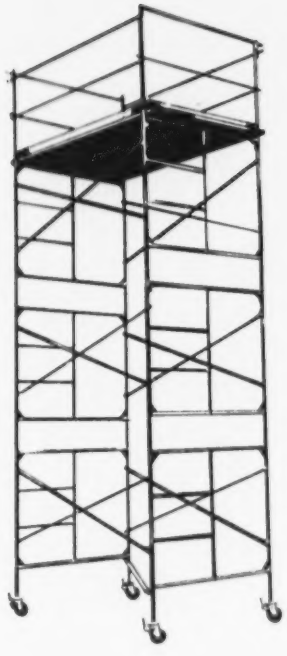


FIGURE 5

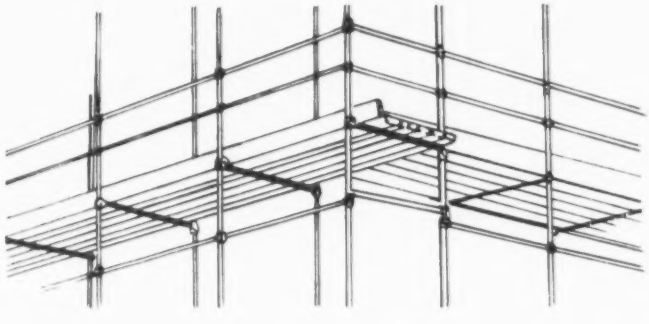
FIGURE 6



Tubular, locking

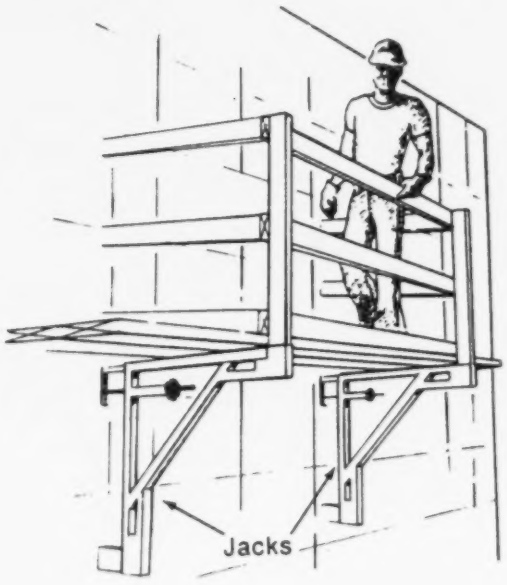
This type of scaffolding can be used with curved or irregular shapes such as cylinders, spheres, and pyramids.

FIGURE 7



— Scaffold jacks with platform

FIGURE 8

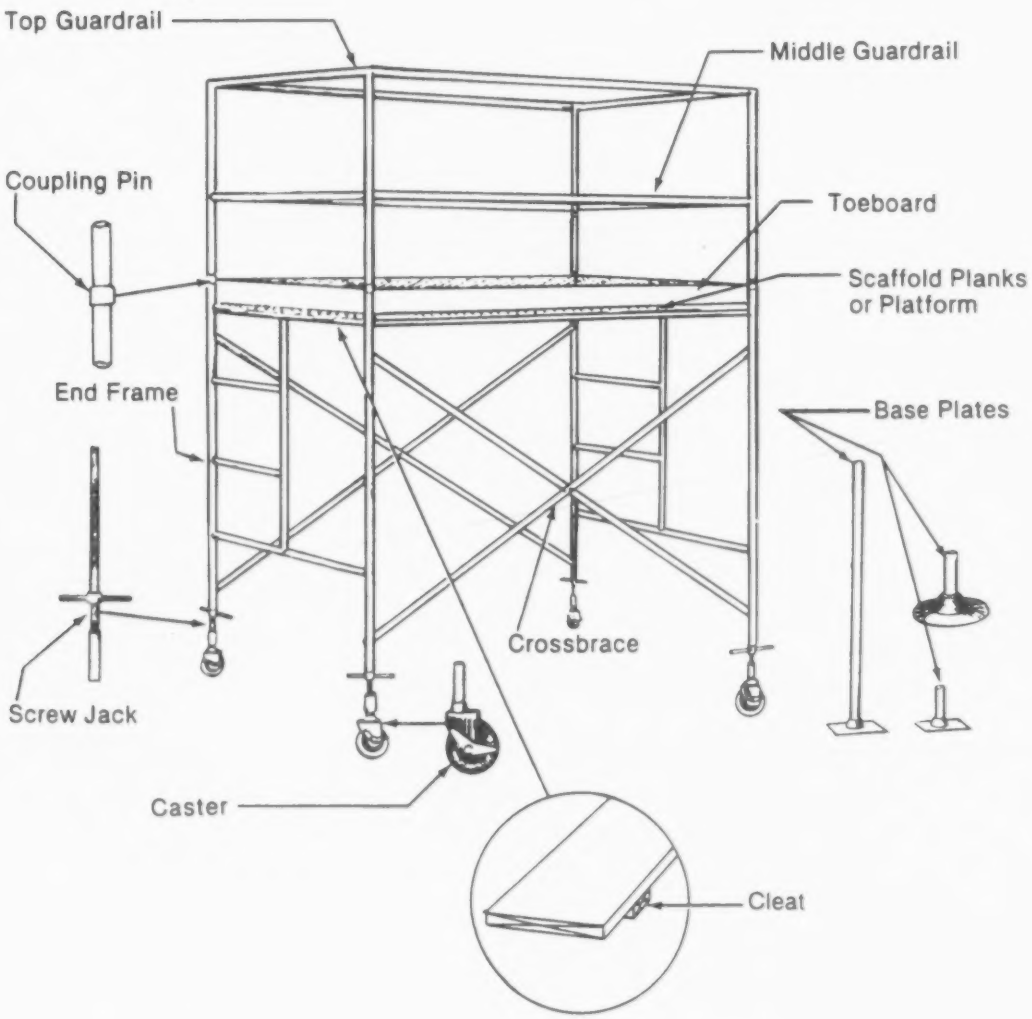


OBJECTIVE 4

Use an illustration to identify the parts of a scaffold.

NOTE: OSHA requires a top guardrail 42 inches high, a midrail halfway between top guardrail and toeboard, and a toeboard just above the scaffold plank or platform.

FIGURE 9



- Use Figure 9 and the following statements to identify parts of a scaffold.

  — **base plates** — for stationary scaffolds, base plates replace the casters and provide stability when used with mud sills

  — **caster** — a wheel used to support a scaffold; mounted in a swivel frame and furnished with brakes

  — **cleat** — a board nailed to the bottom of the scaffold planks to hold them together and to keep them from sliding off the end frames

  — **end frame** — the end panels of metal scaffolds

  — **insert/fastener/coupling pin** — a metal rod used to link scaffold frames

  — **metal sills** — continuous timber placed on the ground to support scaffolds

  — **toeboard** — a four-inch guardrail attached ¼ inch above a scaffold platform to prevent tools and material from falling from the scaffold

  — **top and middle guardrails** — guardrails attached on scaffolds 42 inches high and midway between 42 inches and toeboard

  — **"u" or "j" head** — a device attached to the top of scaffolding to provide attachment of shoring members

OBJECTIVE 5

Choose from alternatives, the proper safety rules for the use of ladders and scaffolds.

NOTE: Follow all OSHA rules and regulations concerning the use of ladders and scaffolds.

- Scaffolding

  — Inspect all scaffold parts before assembly.

  — Always check for electrical wires; deenergize them before erecting metal scaffolding in the vicinity.

- Be sure that the casters are locked on rolling scaffolds before ascending.
- Don't propel or move a scaffold while personnel are on it.
- Do not work on scaffolds during storms, high winds, or when scaffolds are covered with ice and snow.
- Tie off scaffolds about every 25 feet vertically when they are built several sections high and 30 feet horizontally. Check scaffold manufacturer specifics.
- Ensure that scaffolds are level and plumb.
- Do not overload scaffolds.
- Do not climb on crossbraces.
- Be sure that scaffolds are equipped with top rail (42 inches high), midrail, and toeboard.
- Be sure that scaffold boards have cleats when necessary.
- Use safety belts, harnesses, and nets as required.
- Provide adequate mudsills and/or base plates.
- Ensure that lumber for scaffold planks overlap the scaffold end frames.

• Ladders

- Fully spread and lock any stepladder before using.
- Do not use ladders that are not equipped with safety shoes.
- Never overreach from a ladder.
- Never work from the top step or rung of any ladder.
- Below is a table of manufacturer's recommendations for the maximum height workers should ascend on ladders. Workers should always consult manufacturer's specifications.

STEP LADDER		EXTENSION LADDER	
Size	Highest Standing Level	Size	Maximum Working Length
4 Ft.	1 Ft. 11 In.	16 Ft.	13 Ft.
5 Ft.	2 Ft. 11 In.	20 Ft.	17 Ft.
6 Ft.	3 Ft. 10 In.	24 Ft.	21 Ft.
8 Ft.	5 Ft..9 In.	28 Ft.	25 Ft.
10 Ft.	7 Ft. 8 In.	32 Ft.	29 Ft.
12 Ft.	9 Ft. 7 In.	36 Ft.	32 Ft.
		40 Ft.	36 Ft.

— Never use a metal ladder when there is any possibility of contact with electrical conductors.

— Never use ladders in a horizontal position.

— Do not climb on a ladder that is occupied by someone else.

— Remove a ladder when you are finished using it, and always remove and store the ladder at the end of workday.

— Evaluate the jobs in which the ladders will be used. Make sure the combined weight of user, tools, and materials does not exceed the specified working load.

— Before using your ladder, be sure to read and comply with ALL the labels, warnings, and instructions.

— Do not carry loads up a ladder. Ascend the ladder and pull the load up with a rope.

- Positioning ladders

Place ladders approximately one-quarter of their support length away from vertical plane of top support, extension ladders at least 3 feet above top support (Figures 10 and 11)

EXAMPLES:

FIGURE 10

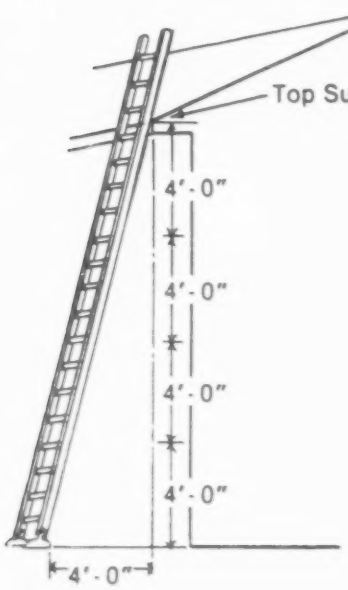
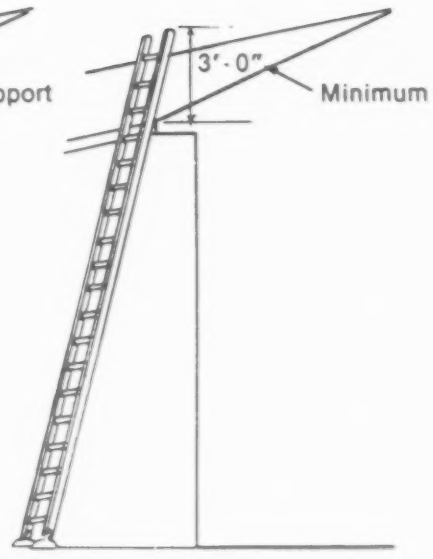


FIGURE 11



One-Fourth the Height of Top Support

Secure ladders at both top and bottom to prevent displacement; brace long ladders at intermediate points to prevent spring.

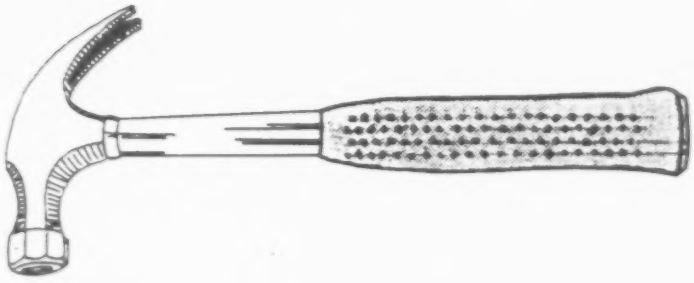
OBJECTIVE 6

Given drawings, identify hand tools used for the construction of highway bridges. (Assignment Sheet 1)

- **Hammers**

  — **curved-claw hammer** — used to drive and pull nails

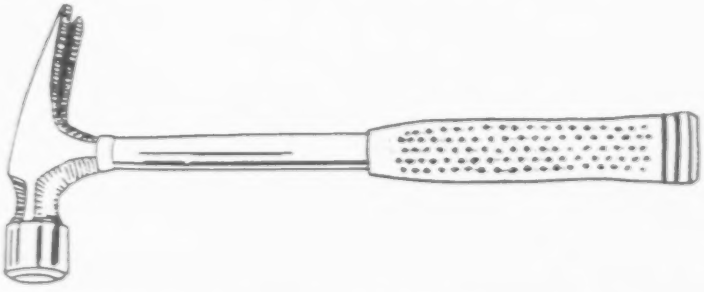
FIGURE 12



Curved-claw hammers weigh from 13 ounces to 20 ounces; handles are made of wood, fiberglass, or steel.

— **straight-claw hammer** — used to drive nails, pull nails, dismantle and wreck

FIGURE 13



Straight-claw hammers weigh from 16 ounces to 21 ounces; straight-claw hammers weighing from 22 ounces to 28 ounces are called *framing hammers*.

— **sledgehammer** — used to drive stakes and break concrete

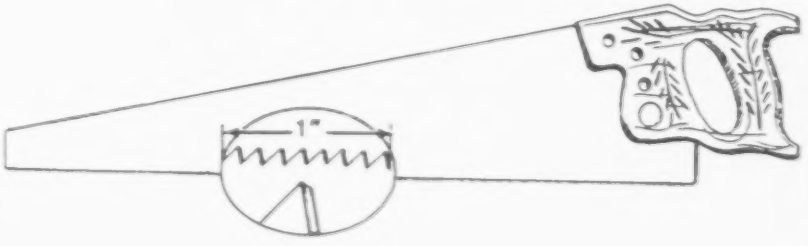
FIGURE 14

Sledgehammers weigh from 2 pounds to 20 pounds; they have a balanced head with two identical faces.

- **Saws**

— **crosscut saw** — used to cut across the grain of wood

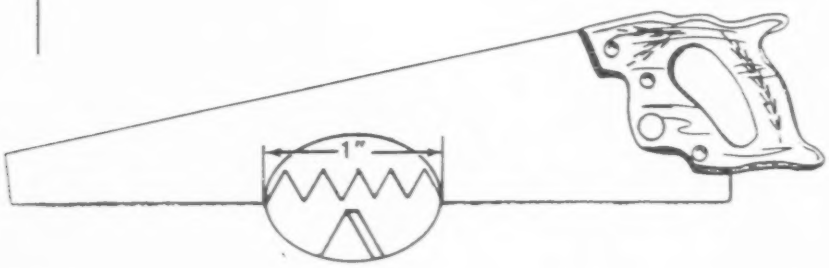
FIGURE 15



Crosscut saws come in lengths of 20 inches to 26 inches with four to twelve points per inch; teeth are filed at an angle across the face.

— **ripsaw** — used to cut with the grain of wood

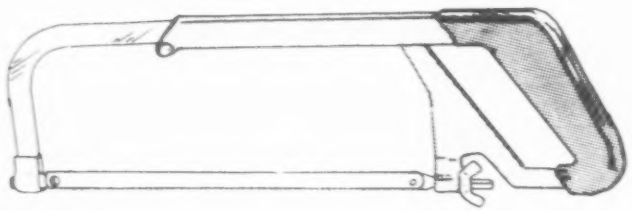
FIGURE 16



Ripsaws come in lengths of 20 inches to 28 inches with five to seven points per inch; teeth are filed square across the face.

— **hacksaw** — used to cut metal

FIGURE 17



Hacksaws have U-shaped frames and replaceable blades that come in lengths of 8 inches to 12 inches.

- **Squares and Accessories**

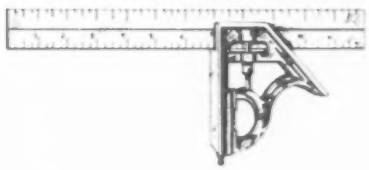
  — **framing square (rafter square)** — used in general framing to lay out forms

FIGURE 18

Framing squares have a 24-inch-by-2-inch calibrated blade and a 16-inch-by-1½-inch calibrated tongue. Rafter and brace tables are stamped on one blade.

— **combination square** — used to check square and to mark 45-degree miters

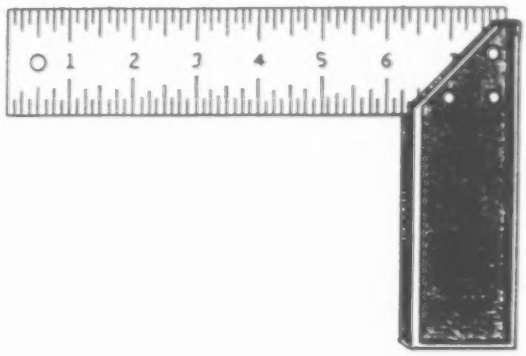
FIGURE 19



Combination squares have a 12-inch blade and an adjustable handle that contains a level vial and a scribe (scratch awl). Handles are made with a 45-degree and a 90-degree side.

— **try square** — used to measure and check 45 and 90-degree angles

FIGURE 20



Try squares have a 6-inch to 12-inch blade that is graduated every ⅛ inch; their stationary handle comes in lengths of 4⅜ inches to 8 inches.

- **Measuring Instruments**

  — **folding rule** — used to make accurate inside measurements

FIGURE 21

Folding rules come in 6-foot or 8-foot lengths.

— **flexible steel tape** — used to measure irregular as well as regular shapes, and to make accurate inside measurements

FIGURE 22

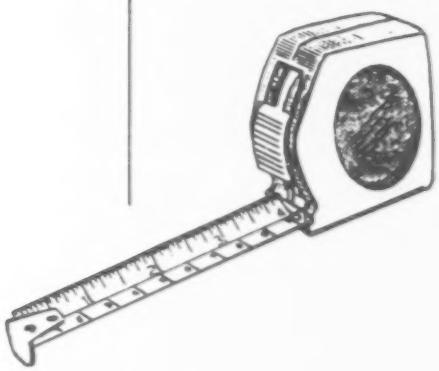
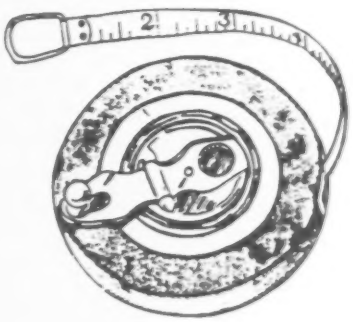


FIGURE 23



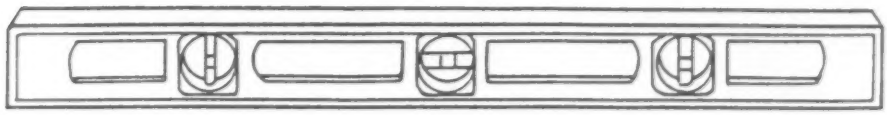
Flexible steel tapes slide into a metal case. Most short tapes come in 6-foot to 25-foot lengths; long tapes come in 50-foot to 100-foot lengths. Both types of flexible steel tapes have a hook or loop on the end adjusted to true zero.

- **Levels**

  Levels are used to check true horizontal and vertical surfaces of objects.

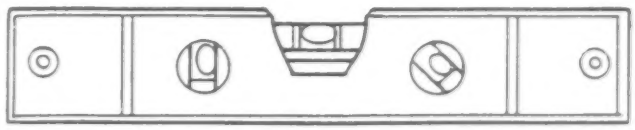
  — **spirit level**

FIGURE 24



— **torpedo level**

FIGURE 25

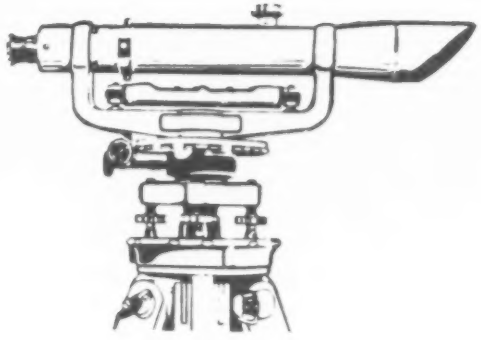


— **line level**

FIGURE 26

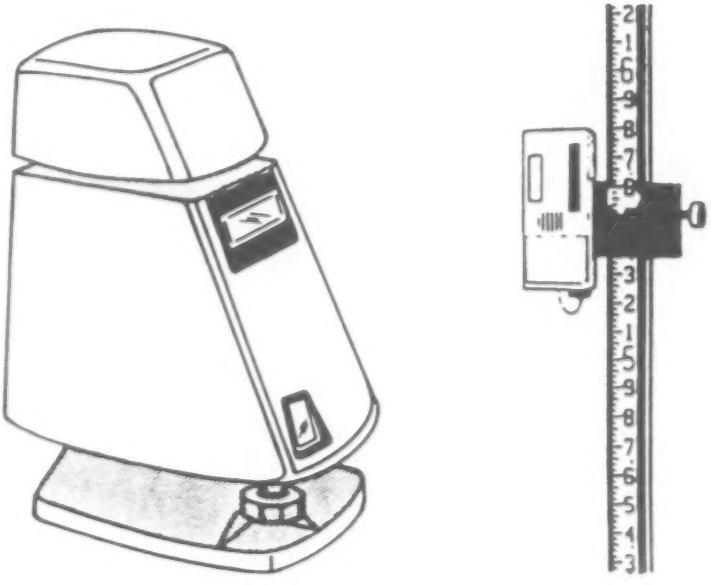
— builder's level

FIGURE 27



— laser-beam level

FIGURE 28



— **plumb bob**

FIGURE 29

A plumb bob is an accessory used with leveling instruments to establish exact building points; it is also used to check true vertical plane of building members.

- **Drilling Tools**

— **power bit (flat bit, spade bit)**

FIGURE 30

Power bits are available in sizes ranging from ¼ inch to 1½ inches and come in $\frac{1}{16}$-inch increments. They have become increasingly popular because the shank is ¼ inch on all sizes.

— **twist drill (spiral drill)**

FIGURE 31

Twist drills are used to drill small holes for nails, screws, etc. Most twist-drill sets range from $\frac{1}{64}$ inch to ½ inch.

— **auger bit**

FIGURE 32

Auger bits are used to drill holes in wood and other softer materials.

— **hole saw**

FIGURE 33

Hole saws consist of a hollow cylinder with teeth around its edge; they are used for cutting round holes.

- **Screwdrivers**

Select a screwdriver that is shaped to fit the screw slot properly and is ground to the correct size. If the screwdriver is too large, it will damage the screw head. If the screwdriver is too small, it will be damaged.

— **standard screwdriver** (flat tip or flat blade screwdriver)

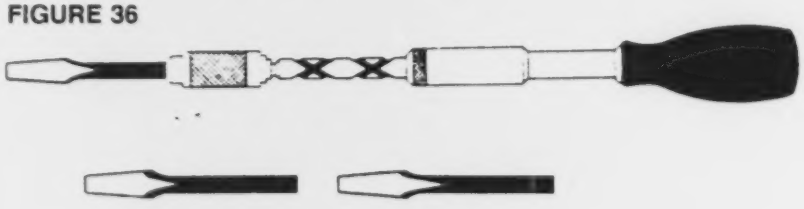
FIGURE 34

— **Phillips screwdriver**

FIGURE 35

— **spiral ratchet screwdriver** (automatic screwdriver)

FIGURE 36



Spiral ratchet screwdrivers operate with a pushing-up-and-down action rather than with a turning action.

— **standard screwdriver bit**

Standard screwdriver bits must be used with a hand brace.

FIGURE 37

— **Phillips screwdriver bit**

FIGURE 38

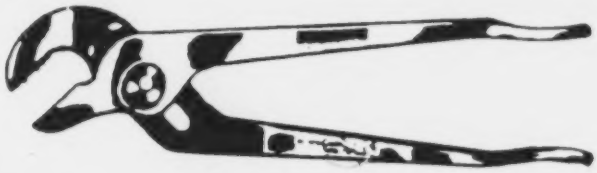
- **Pliers**

— **side-cutting pliers** — used to hold, bend, shape, and cut wire

FIGURE 39

— **channel-lock pliers** — used to hold and turn large round parts

FIGURE 40



- **Wrenches**

In building construction, wrenches are used to set up and adjust machinery and to work with hardware and fasteners.

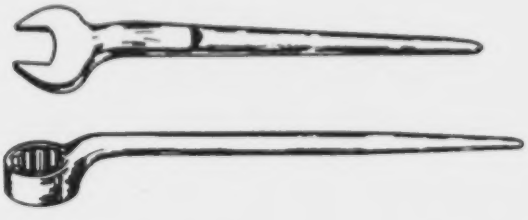
— **open-end wrench**

FIGURE 41

Open-end wrenches have an accurately machined, nonadjustable opening in each end; sizes of these openings are stamped on the tool. Open-end wrenches are used where there is plenty of clearance for movement.

— **spud wrench**

FIGURE 42



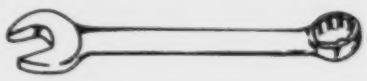
— **box-end wrench**

FIGURE 43

Box-end wrenches have two enclosed, nonadjustable heads that may be offset from 15 degrees to 45 degrees; they are used where there is limited space for movement.

— **combination wrench**

FIGURE 44



Combination wrenches have an open-end wrench at one end and a box-end wrench at the other end.

— **adjustable wrench**

FIGURE 45

Adjustable wrenches have one adjustable jaw and one fixed jaw; they are used where there is plenty of clearance for movement.

— **ratchet wrench and socket**

FIGURE 46

Ratchet wrench/socket

Ratchet wrenches contain a ratchet that allows torque to be applied in one direction only; sockets of various sizes may be attached to the wrench.

- **Files**

Files are used to smooth and shape surfaces on which edge-cutting tools cannot be used. Files come in various shapes, sizes, and types of cuts.

— **flat (mill and bastard)**

FIGURE 47

— **file handle (used with all files)**

FIGURE 48

- **Chisels**

Chisels are used for joint construction, for removal or stripping of excess material, and for cutting masonry and steel.

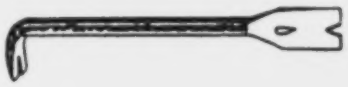
— **wood chisel**

FIGURE 49

Wood chisels come in blade sizes of ¼-inch to 2 inches in ¼-inch increments.

— **nail puller**

FIGURE 50

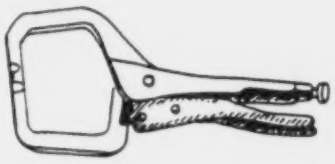


- **Clamps**

Clamps are tools for binding or pressing two or more parts together and holding them firmly in their relative positions; they are often used to hold pieces of metal together while being welded.

— **locking C-clamp**

FIGURE 51



- **Miscellaneous tools**

— **Tie wire reel**

FIGURE 52

— **Tying tool** — used with pigtails

FIGURE 53

- **Bar benders**

  — **Rod bender (Hickey)**

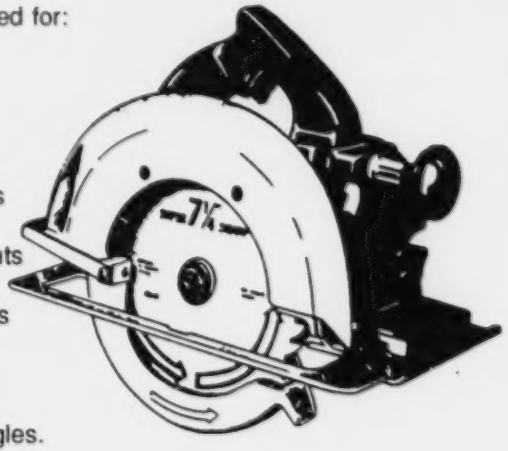
FIGURE 54

OBJECTIVE 7

Given drawings, identify power tools and equipment used for the construction of highway bridges. (Assignment Sheet 2)

- **Power tools**

  A. **circular saw** **FIGURE 55**



The circular saw is used for:

— ripping

— crosscutting

— making miter cuts

— making pocket cuts

— making bevel cuts

Safe use guidelines:

— Wear safety goggles.

— Hold the saw firmly.

— Always start the saw before making contact with material.

— Keep the electric cord clear of the blade to avoid cutting it.

— Check the condition of the blade and be sure it is secure before starting the saw.

— Be sure the blade guards are in place and working properly.

— Set the blade only deep enough to cut through the material you are using.

— Check stock for nails and any other metal before cutting it.

— Be sure the saw has attained maximum speed before starting the cut.

— Be sure the material being cut is properly supported.

— Keep your hands clear of the blade.

— If the blade binds in a cut, stop the saw immediately and hold it in position until the blade stops, then back it out of the cut.

— Stop the saw and lay it on its base after finishing the cut.

B. **drill** **FIGURE 56**

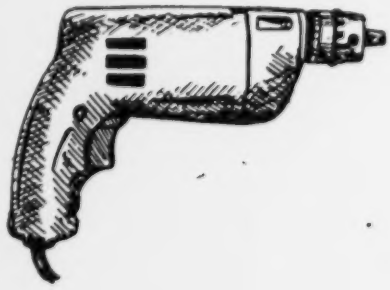
The drill is used for:

— boring and drilling

— cutting holes with a hole saw

— mixing materials

— driving screws



Safe use guidelines:

— Wear safety goggles.

— Hold the tool firmly.

— Always remove the chuck key before starting the drill.

— Be sure the drill or tool is secure in the chuck before starting the drill.

— Never attempt to stop the drill by taking hold of the chuck.

— Do not force the drill into the material.

— Be sure the material is properly secured before drilling.

— Never point the drill at anyone.

C. **angle grinder** **FIGURE 57**

The angle grinder is used for:

— rough sanding

— grinding metal

— grinding concrete

— polishing and buffing

— removing rust and scale from steel

— wire brushing

Safe use guidelines:

— Be sure the grinding head is in good condition and properly secured.

— Wear safety goggles.

— Wear gloves when appropriate.

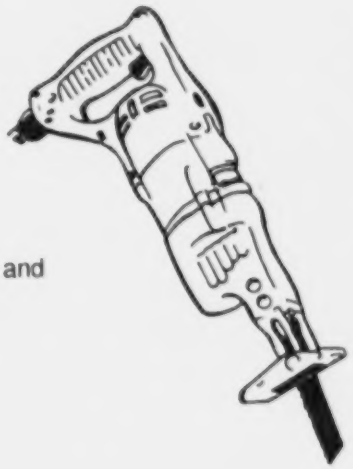
— Use the proper grinding head for the material being ground.

EXAMPLES: Head for steel, head for concrete

— Be sure the grinder head has stopped turning before laying the grinder down.

D. **reciprocating saw** **FIGURE 58**

The reciprocating saw is used for:



— making irregular cuts

— crosscutting

— making relief cuts

— making inside curves and corner cuts

— making pocket cuts

Safe use guidelines:

— Wear safety goggles.

— Keep your hand clear of the blade.

— Hold the saw firmly.

— Be sure the blade has clearance on the opposite side of the material.

— Keep the electric cord clear of the blade to avoid cutting it.

— Do not force the blade into the material.

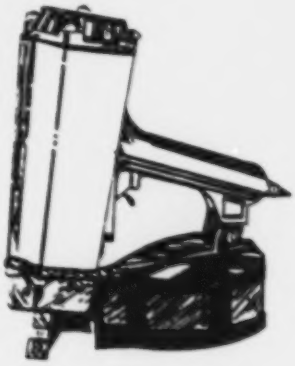
— Use the correct blade for the job being done.

— Turn off the saw immediately after finishing the cut.

— Be sure the material being cut is properly supported.

E. **pneumatic nailer** **FIGURE 59**

The pneumatic nailers are used for:



— applying sheathing

— applying decking

— applying roofing

— installing framing

— installing finish work

— constructing cabinets

Safe use guidelines:

— Wear safety goggles.

— Be sure all safety devices are in good shape and functioning properly.

— Use the pressure specified by the manufacturer.

— Always assume that the nailer is loaded.

— Never point a pneumatic nailer at yourself or anyone else.

— Be sure the nailer is disconnected from the power source before making adjustments of repairs.

— Use caution when attaching the nailer to the air supply because the fastener may discharge.

— Never leave a pneumatic nailer unattended while it is still connected to the power source.

— Use nailers and staplers only for the type of work for which they were intended.

— Use only nails and staples designed for the fastener being used.

— Never use nailer on soft or thin materials that nails may go through.

F. **powder-actuated tool FIGURE 60**

The powder-actuated tool is used for:

— driving pins and threaded studs

— fastening wood to concrete

Safe use guidelines:

WARNING: Before using a powder-actuated tool, the operator must be certified and must possess a safety certification. Certification cards must be issued by an authorized company representative for the tool being use.

— Do not use a powder-actuated tool until you are certified.

NOTE: See your instructor about certification.

— Follow **all** safety precautions in the manufacturer's instruction manual.

— Always wear safety goggles and a hard hat when operating a powder-actuated tool.

— Use the proper pin size for the job you are performing.

— Use the correct booster according to the selector chart in the toolbox.

— Never hold the end of the barrel against any part of your body or cock the tool against your hand.

— Never hold your hand behind the material you are fastening.

— Do not shoot close to the edge of concrete.

— Never attempt to pry the booster out of the magazine with a sharp instrument.

— Always wear ear protection in a confined area.

G. **radial arm saw** **FIGURE 61**

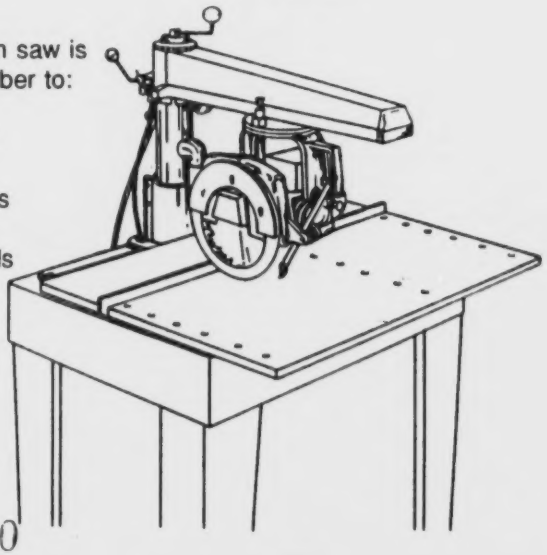
The radial arm saw is used with lumber to:

— crosscut

— cut miters

— cut bevels

— ripping



— cut dadoes

— cut grooves

— shaping

— routing

Safe use guidelines:

— Wear a hard hat.

— Wear safety glasses/goggles.

— Keep your hands out of the line of the rotating cutters.

— Keep guards in proper position.

— Follow manufacturer's guidelines and OSHA regulations for the safe use of a radial saw.

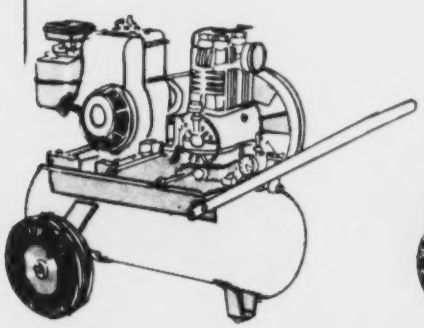
— Keep long hair, ties, clothing, etc. out of contact with rotating blade.

- Equipment

A. Air compressors

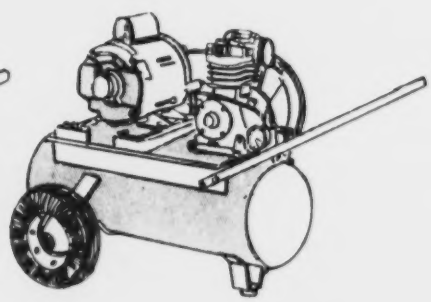
— Gasoline

FIGURE 62



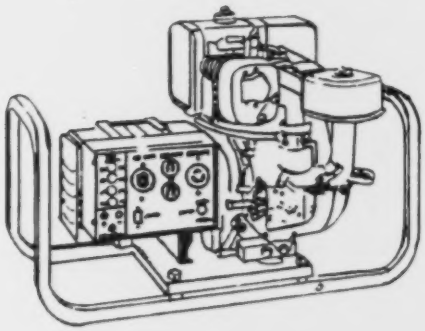
— Electric

FIGURE 63



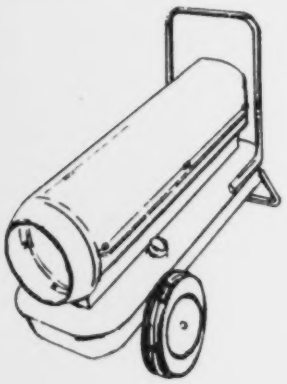
B. Generator

FIGURE 64



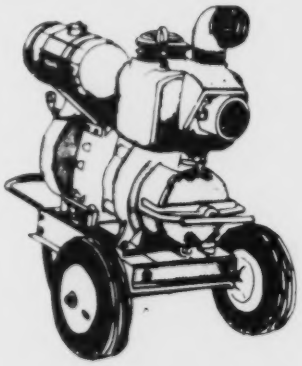
C. Space heater

FIGURE 65



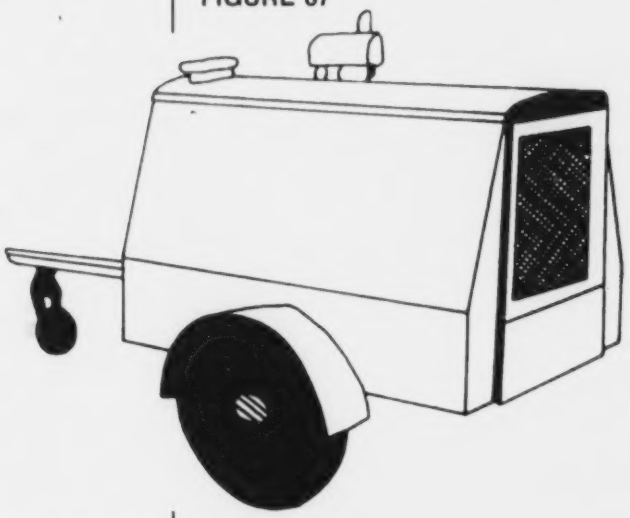
D. Water pump

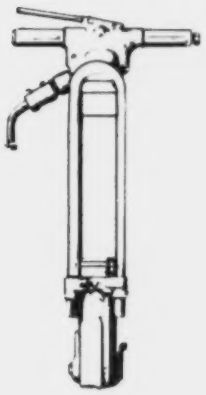
FIGURE 66



E. Air compressor and paving breaker

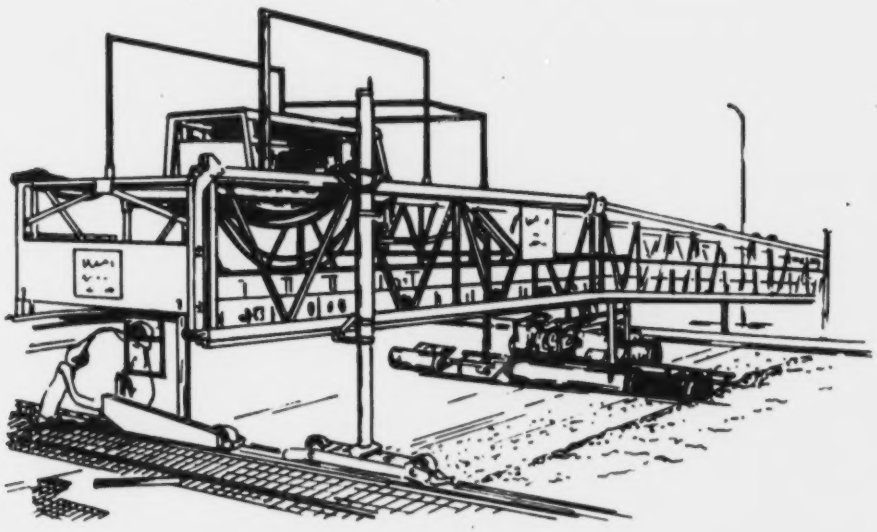
FIGURE 67





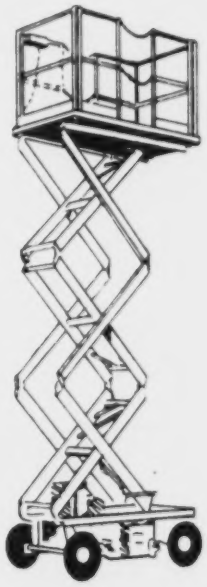
F. Concrete finisher

FIGURE 68



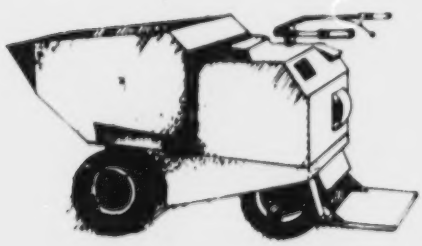
G. Power lift

FIGURE 69



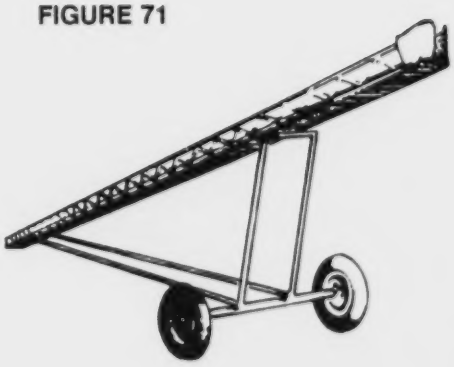
H. Power buggy

FIGURE 70



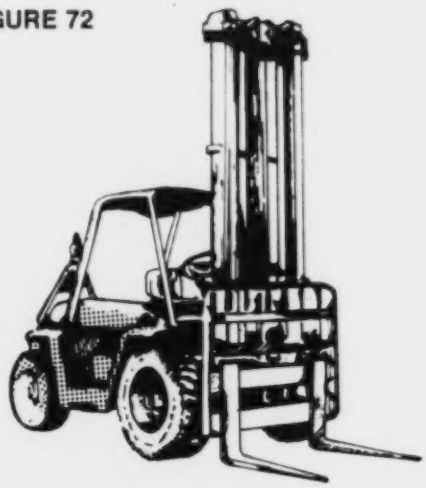
I. Conveyor

FIGURE 71



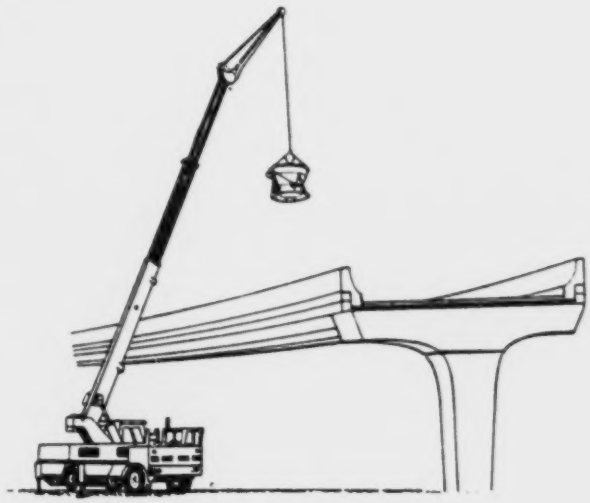
J. Forklift

FIGURE 72



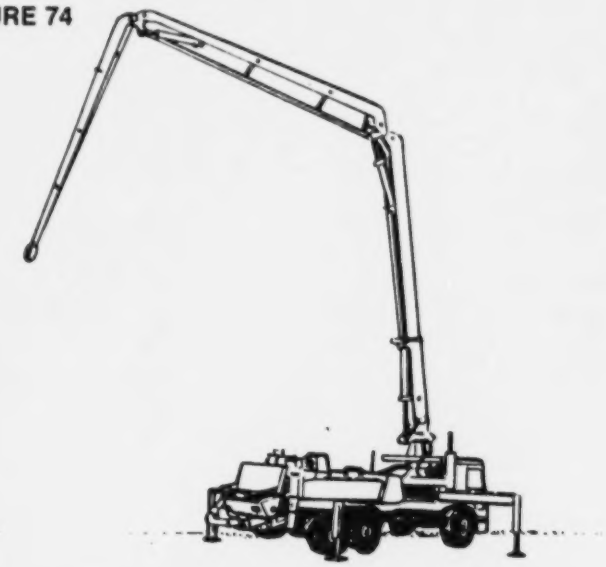
K. Hydraulic truck crane

FIGURE 73



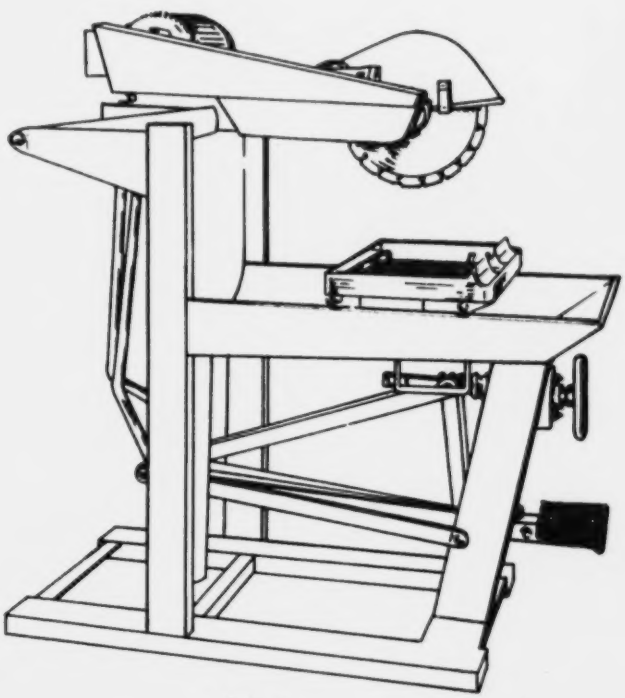
L. Concrete placing boom (with concrete pump)

FIGURE 74

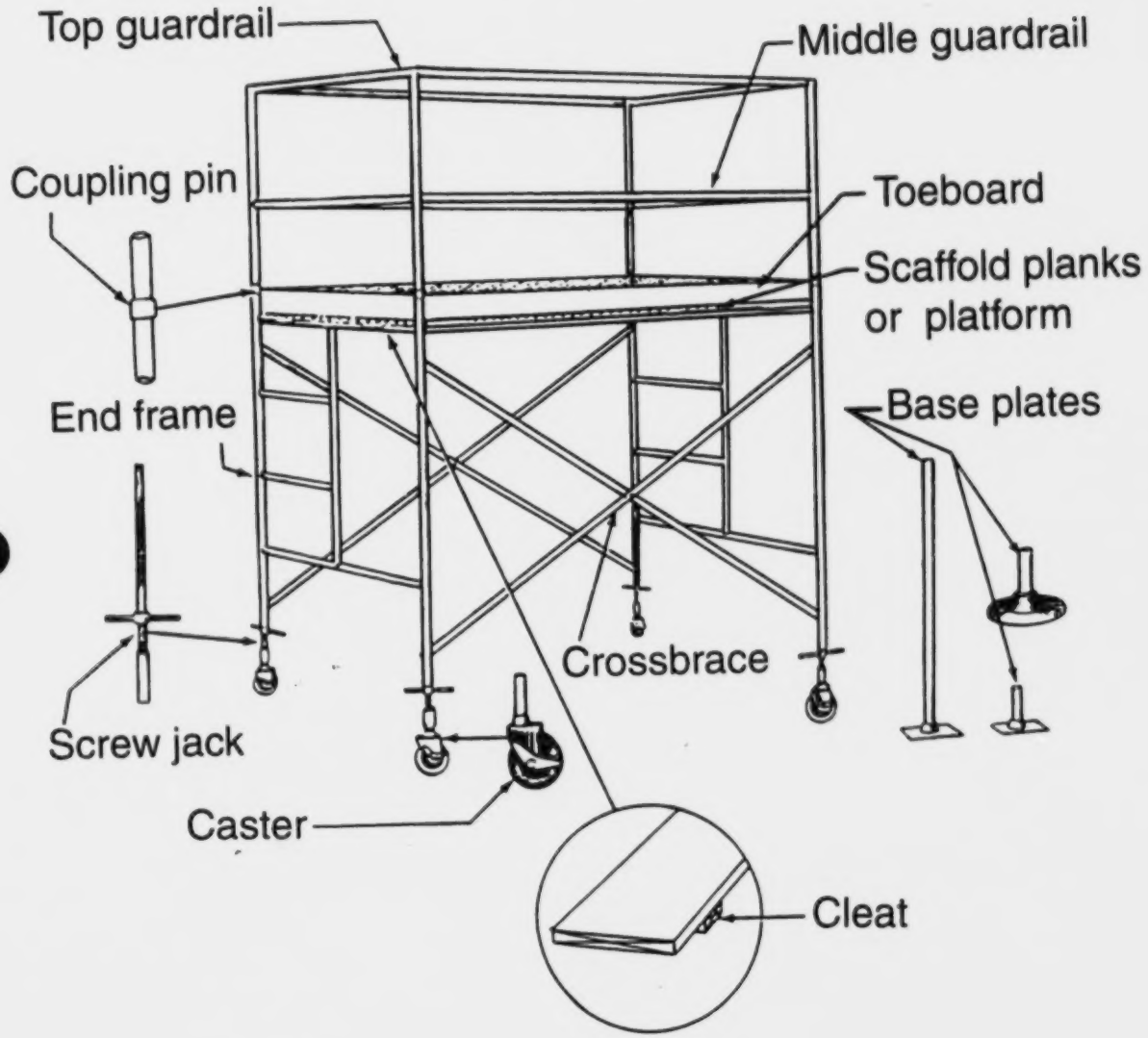


M. Cuttoff saw

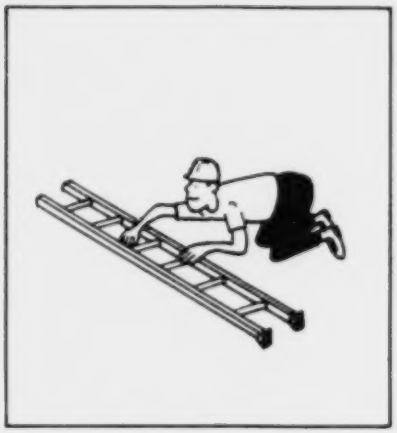
FIGURE 75



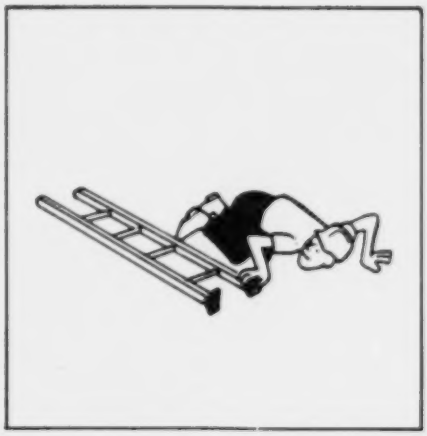
Parts of a Scaffold



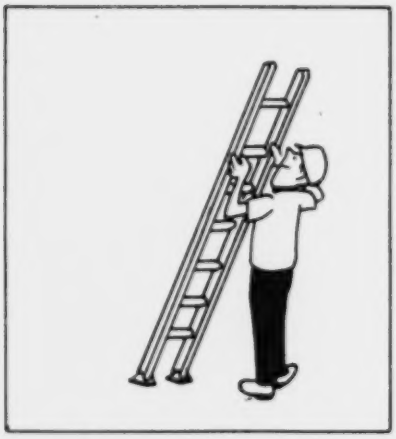
Ladder Safety



Check Condition



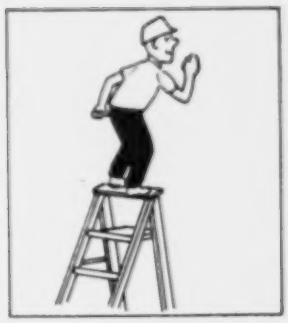
Check Safety Shoes



Check Load Limit

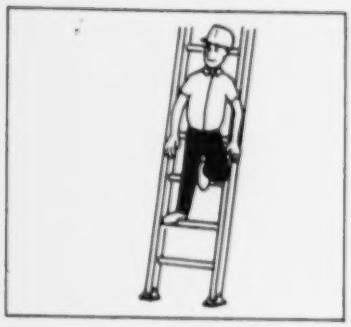
Place at Safe Angle

Ladder Danger



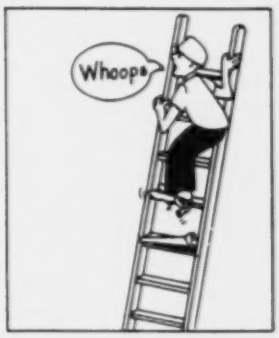
Standing on Top Rung

Facing Away from Ladder



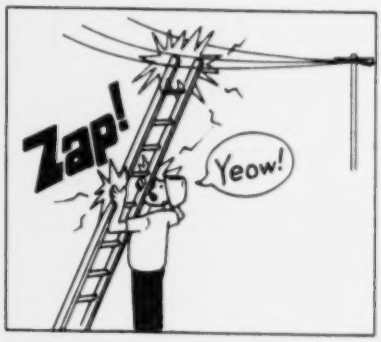
Reaching Too Far

Slipping from Slick, Oily Shoes



Slipping on Tools Left on Ladder

Contacting Electrical Lines with Metal Ladder



ASSIGNMENT SHEET 1

HIGHWAY BRIDGE TOOLS — A 2

Name _____ Score _____

OBJECTIVE 6

Given drawings, identify hand tools used for the construction of highway bridges.

INTRODUCTION

This exercise will give you practice identifying common tools used to cut, splice, bend, and install concrete reinforcing steel.

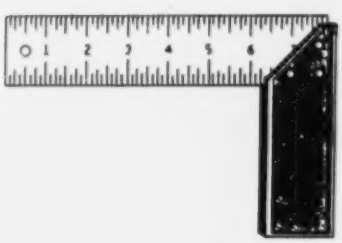
INSTRUCTIONS

Identify tools used to install concrete reinforcing steel. Write the correct names in the blanks.

Functional Reading Skills
- Interpret graphics and symbols

Functional Writing
- Complete forms and records

Combination square	Hacksaw	Steel tape
Torpedo level	Try square	Locking C-clamp
Standard screw-driver	Folding rule	Plumb bob
Twist drill	Sledgehammer	Spirit level
Rod bender	Channel-lock pliers	Bolt cutters
Tire wire reel	Framing square	Tying tool
Laser beam level	Straight claw hammer	Spud wrench
	Hole saw	Builder's level
	Side-cutting pliers	Nail puller
	Box-end wrench	Power bit



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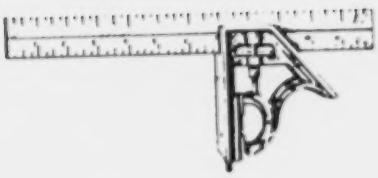

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5. _____

6. _____

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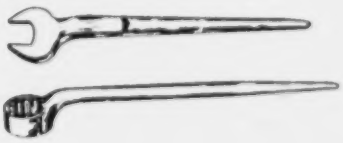

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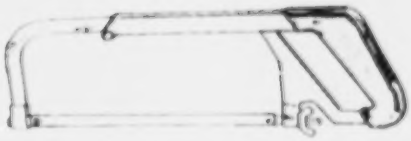
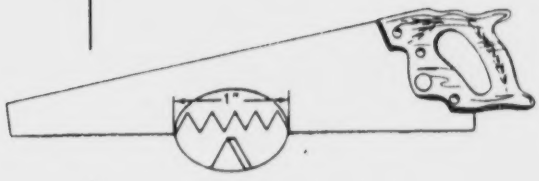


9. _____ 10. _____

11. _____

12. _____ 13. _____

14. _____ 15. _____



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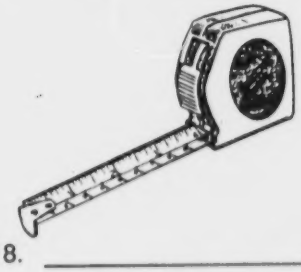

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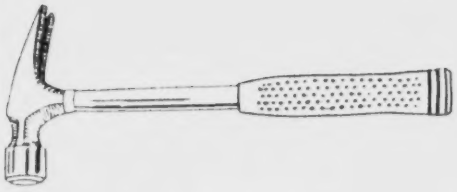

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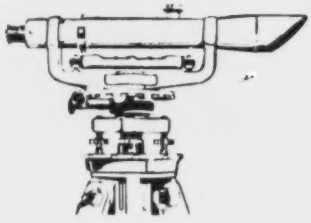
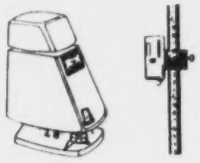


25. _____



26. _____

ASSIGNMENT SHEET 2	HIGHWAY BRIDGE TOOLS	A 2

Name _____ Score _____

OBJECTIVE 7

Given drawings, identify power tools and equipment used for the construction of highway bridges.

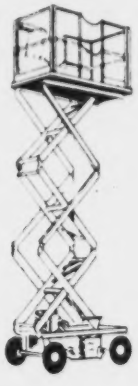
INTRODUCTION

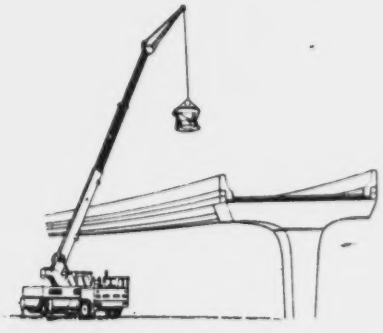
Practice the identification of power tools and equipment used for the construction of highway bridges.

INSTRUCTIONS

Identify power tools and equipment by writing the correct titles in the appropriate blanks.

Hydraulic truck crane
Conveyor
Radial arm saw
Electric air compressor
Reciprocating saw
Pneumatic nailer
Circular saw
Drill
Power lift
Power buggy
Water pump
Gasoline air compressor

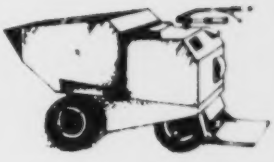




1. _____

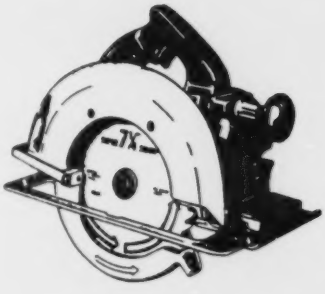
2. _____

votech

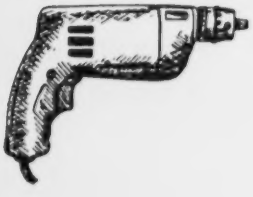


3. _____

4. _____



5. _____



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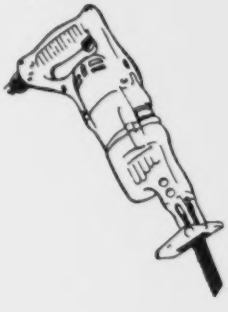

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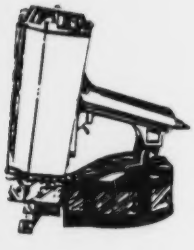

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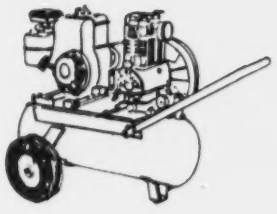

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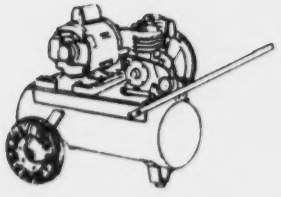

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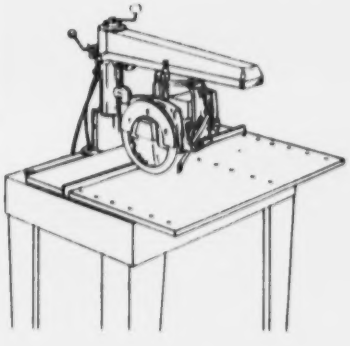
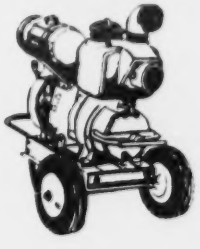


11. _____



12. _____

ASSIGNMENT SHEET 1

1. Twist drill
2. Try square
3. Framing square
4. Combination square
5. Box-end wrench
6. Torpedo level
7. Plumb bob
8. Spud wrench
9. Channel-lock pliers
10. Hacksaw
11. Spirit level
12. Folding rule
13. Hole saw
14. Side-cutting pliers
15. Power bit
16. Tying tool
17. Rod bender or hickey
18. Steel tape
19. Tie wire reel
20. Nail puller
21. Locking C-clamp
22. Sledgehammer
23. Straight-claw hammer
24. Standard screwdriver
25. Builder's level
26. Laser-beam level

ASSIGNMENT SHEET 2

1. Power lift
2. Hydraulic truck crane
3. Power buggy
4. Conveyor
5. Circular saw
6. Drill
7. Reciprocating saw
8. Pneumatic nailer
9. Gasoline air compressor
10. Electric air compressor
11. Radial arm saw
12. Water pump

JOB SHEET 1

HIGHWAY BRIDGE TOOLS

A 2

OBJECTIVE 8

Use a hammer properly.

INTRODUCTION

The hammer is one of the most used tools in carpentry. This exercise will describe how to use a claw hammer to drive and pull nails.

EQUIPMENT AND SUPPLIES

- Hard hat and safety goggles
- Claw hammer
- Nails
- Two 2×4 blocks

PROCEDURE

- Driving nails

Yes No

1. Put on safety equipment. ___ ___

2. Grasp hammer handle firmly near the end (Figure 76). ___ ___

Functional Reading Skills
- Follow written instructions

FIGURE 76

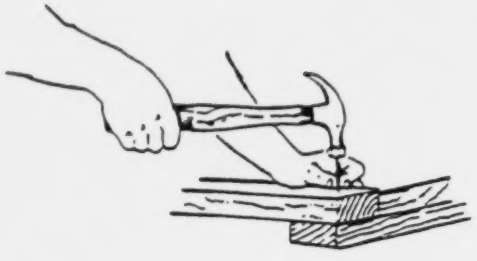
Job Acquisition/ Development Skills
- Master specific job task/procedure

3. Place one 2×4 on top of another 2×4. ___ ___

Yes No

4. Rest the face of hammer on the nail held in the other hand (Figure 77). ___ ___

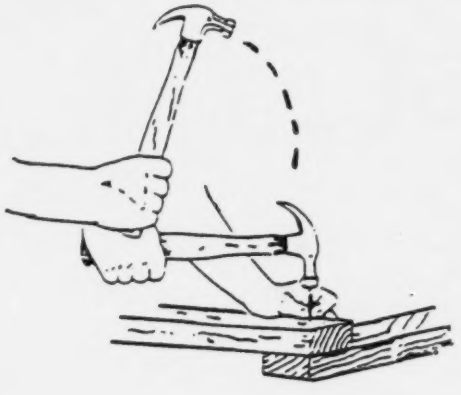
FIGURE 77



5. Raise the head of the hammer and give a light tap to start nail and to determine the aim (Figure 78). ___ ___

   NOTE: This maneuver is accomplished through the wrist, elbow, and shoulder with one or all being used according to the strength of the blow to be struck.

FIGURE 78

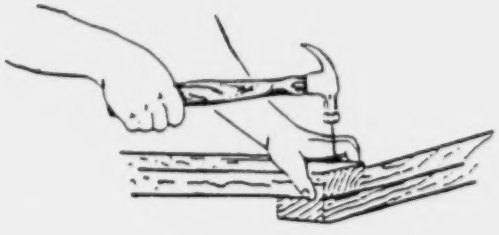


Yes No

6. Strike the nail squarely to avoid marring the wood and bending the nail (Figure 79). ___ ___

   Keep the face of hammer clean to avoid its slipping off the nail.

FIGURE 79



- Pulling nails ___ ___

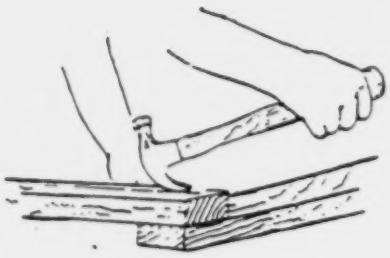
  1. Grasp the hammer handle firmly near the end, just opposite from the grasp used for driving nails (Figure 80).

FIGURE 80

Yes No

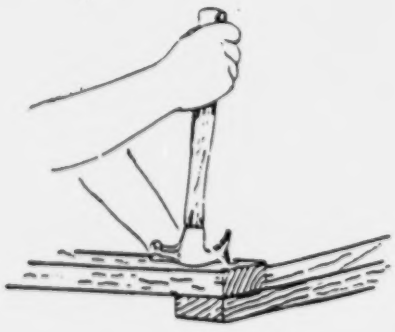
2. Slip claw of the hammer under the nail head and apply pressure (Figure 81). ___ ___

FIGURE 81



3. Continue applying pressure by pulling back on the handle until the handle is nearly vertical (Figure 82). ___ ___

FIGURE 82



	Yes	No
4. This concludes this job sheet. Ask your instructor to evaluate your work.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Used safety equipment	4	3	2	1
Grasped hammer by end	4	3	2	1
Started nail properly	4	3	2	1
Avoided marring of wood	4	3	2	1
Drove nail straight	4	3	2	1
Pulled nail properly	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 2	HIGHWAY BRIDGE TOOLS	A 2

OBJECTIVE 9

Use a handsaw.

INTRODUCTION

This exercise allows you to practice using a handsaw to cross cut (across the wood grain) and rip (with the wood grain) lumber.

EQUIPMENT AND SUPPLIES

- Hard hat and goggles
- Cross cut handsaw
- Rip saw
- Pencil
- Saw horses (1 pair)
- 1×6 approximately 4' long
- Square
- Wedge

PROCEDURE

Functional Reading Skills

- Follow written instructions

Job Acquisition/ Development

- Master specific job task/procedure

- Cross cutting lumber

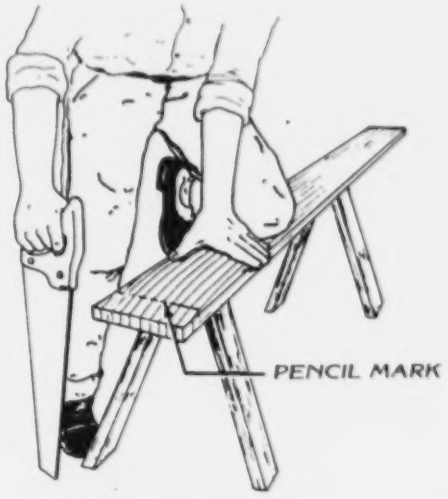
	Yes	No
1. Put on your safety equipment.	___	___
2. Using a square, mark a line across one end of a 1×6.	___	___
3. Firmly grasp the cross cut handsaw.	___	___

General
Science Skills
- Use scientific instruments

Yes No

4. Place one knee on 1×6 to hold it firmly in place; align saw blade with mark (Figure 83). ___ ___

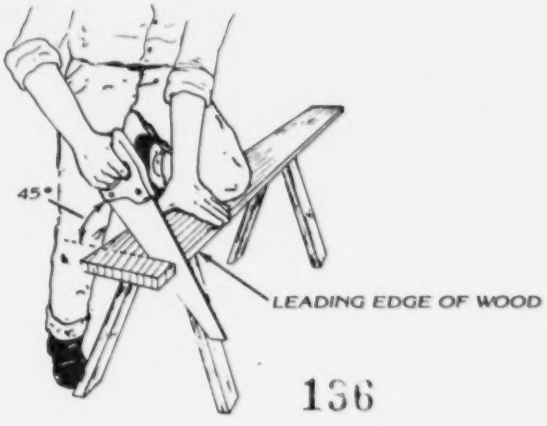
FIGURE 83



5. Position saw at about 45-degree angle between the sawhorse and the 1×6 and start the cut by drawing the saw backward, then forward (Figure 84). ___ ___

NOTE: Always cut on the waste side of the mark. This will ensure the lumber to be used will be the correct length.

FIGURE 84



	Yes	No
6. Hold blade of saw square to the stock, and steady the blade at the mark with your thumb.	___	___
7. Continue these procedures until the cut is made.	___	___
8. Have your instructor check your work.	___	___
9. Clean up work area, and put away tools and materials.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Safety equipment used	4	3	2	1
Lumber cut squarely	4	3	2	1
Saw held at correct angle	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of crite a. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** – Can perform job with no additional training
3 **Moderately Skilled** – Has performed job during training program; limited additional training may be required
2 **Limited Skill** – Has performed job during training program; additional training is required to develop skill
1 **Unskilled** – Is familiar with process, but is unable to perform job

JOB SHEET 3	HIGHWAY BRIDGE TOOLS	A 2

OBJECTIVE 10

Use a level.

INTRODUCTION

Levels are very delicate instruments and must be handled carefully to ensure accuracy. Levels should be checked for accuracy periodically and before use, especially if the instrument has been dropped or jarred.

EQUIPMENT AND SUPPLIES

- Four-foot spirit level
- Folding rule or steel tape
- Pencil
- Straightedge
- Vertical and horizontal work surface

PROCEDURE

Functional Reading Skills
- Follow written instructions

Data Analysis and Display Skills
- Interpret graphs

- Master specific job task/procedure

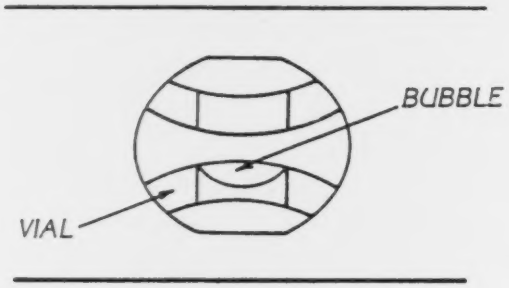
		Yes	No
1.	Check the level for accuracy.		
a.	Set the base of level on flat, horizontal surface.	___	___
b.	Check the bubble position in horizontal vial.	___	___
c.	Adjust the surface or location of level until bubble is centered; mark position on surface.	___	___

NOTE: On a level surface, the bubble will lie evenly positioned between the lines on the vial (Figure 85).

- Complete job-related applications
- Practice good work habits/attitudes

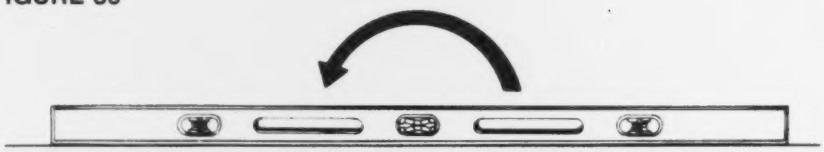
Yes No

FIGURE 85



d. Rotate the level end for end and position it on the exact location; use the bottom bubble. ___ ___

FIGURE 86



e. Check the bubble position in the horizontal vial. ___ ___

NOTE: The bubble will be centered from this side also if the level is accurate.

f. Replace or repair the level as necessary. ___ ___

Yes No

2. Level a surface. ___ ___

   a. Visually check the surface for irregularities and foreign matter such as dirt.

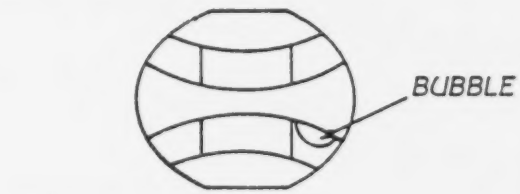
   b. Clean or replace surface as necessary. ___ ___

   c. Set the base of level carefully and squarely on surface. ___ ___

   d. Check the bubble position. ___ ___

      NOTE: The bubble will be displaced toward the high end of the level (Figure 87).

FIGURE 87



   e. Adjust the surface as necessary. ___ ___

   f. Take additional readings to level the surface as required. ___ ___

      NOTE: Many factors, such as the type of surface and the material being used, affect the number of readings that are required.

PROCEDURE FOR PLUMBING

Plumb a vertical surface.

Yes No

1. Check the level for accuracy.

   a. Place base of the level against flat, vertical surface (see Figure 88). ___ ___

   b. Check the bubble position in upper horizontal vial. ___ ___

   c. Adjust the surface or location of level until bubble is centered; mark position on surface. ___ ___

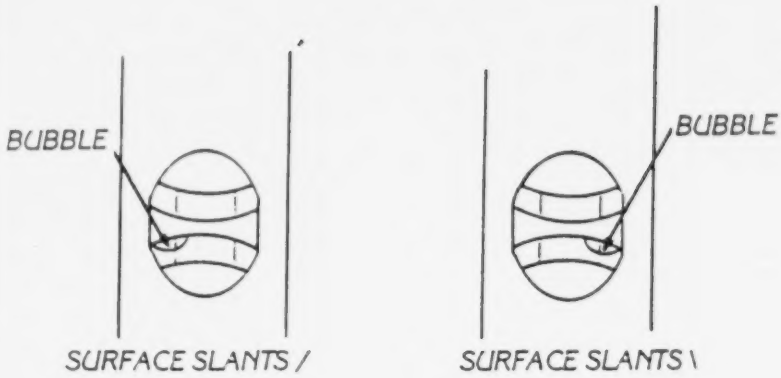
FIGURE 88

FIGURE 89

		Yes	No
d.	Rotate the level, end for end, and position it on the exact location of the bubble-centered reading. (Figure 89)	___	___
e.	Check the bubble position in the upper horizontal vial. **NOTE:** The bubble will be centered at this end also if level is accurate.	___	___
f.	Replace or repair level as necessary.	___	___
2.	Plumb a surface.		
a.	Visually check the surface for irregularities and foreign matter such as dirt.	___	___
b.	Clean or replace the surface as necessary.	___	___
c.	Place the base of level carefully and squarely against surface.	___	___
d.	Check the bubble position in upper vial. **NOTE:** The bubble will move toward one end of the vial if the surface is not plumb. To plumb the surface, you must adjust it in the direction of bubble displacement (Figure 90).	___	___

Yes No

FIGURE 90



e. Adjust the surface as necessary. ___ ___

f. Take additional readings to plumb as required. ___ ___

3. Have your instructor check your work. ___ ___

4. Clean work area; put away all tools and equipment. ___ ___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Accuracy of level verified	4	3	2	1
Surface is level	4	3	2	1
Vertical surface is plumb	4	3	2	1
Time standard for a 4 rating is 10 minutes or less	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 4	HIGHWAY BRIDGE TOOLS	A 2

OBJECTIVE 11

Perform a crosscut using a radial arm saw.

INTRODUCTION

This job sheet will give you practice in the safe use of a radial arm saw to crosscut lumber.

Be certain your instructor/supervisor has provided you a demonstration as to the safe and proper use of the saw.

EQUIPMENT AND SUPPLIES

- Hard hat and safety glasses/goggles
- Radial arm saw with crosscutting blade
- 1″ × 4″ or 2″ × 4″ lumber of 2′ or greater length
- Tape measure
- Pencil

PROCEDURE

Functional Reading Skills
- Follow written instructions

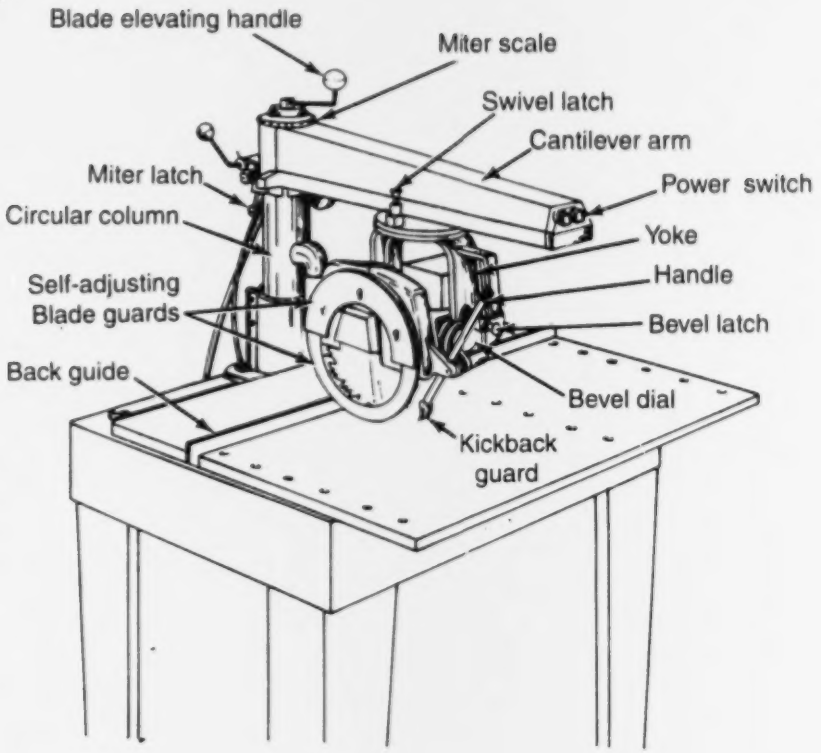
Math Application Skills
- Use English and metric measures

	Yes	No
1. Put on hard hat and eye safety.	___	___
2. Use Figure 91 to locate radial arm saw operator controls.	___	___

FIGURE 91

Yes No

General Science Skills
- Use scientific instruments



3. With the power switch turned off, ensure the bevel dial is set to "0" (zero) and the swivel latch is set so the radial arm is at right angles to the back guide. ___ ___

		Yes	No
4.	Using a tape measure, mark the lumber to be cut at 12" from the end. **NOTE:** For personal safety, do not attempt to crosscut lumber shorter than 2' in length during this exercise.	___	___
5.	Now adjust the blade elevating handle so the blade height allows the saw to be set slightly below the surface of the wooden saw table.	___	___
6.	Push the saw to the rear, against the stop.	___	___
7.	Place the lumber to be cut against the back guide with the cutoff mark aligned with the saw blade.	___	___
8.	Adjust the kickback guard so it will slightly clear the lumber you are cutting.	___	___
9.	Make sure the saw is at its rearmost position and that you are securely holding the lumber against the back rail.	___	___
10.	Ensure your hands are safely away from the blade, turn the power switch on.	___	___
11.	Once the saw has reached maximum speed, grasp the handle of the saw with your free hand.	___	___
12.	Draw the blade forward, making the cut.	___	___
13.	Without moving the lumber, return the saw to the rear stop.	___	___
14.	Turn off the saw power.	___	___
15.	Allow the saw to stop and carefully pull the cut lumber off the table.	___	___
16.	Allow your instructor to evaluate your work.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Properly measured lumber (±⅛")	4	3	2	1
Used safety equipment	4	3	2	1
Adjusted saw properly for a crosscut	4	3	2	1
Awaited for saw to stop before removing lumber	4	3	2	1
Adjusted kickback guard properly	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

WRITTEN TEST

HIGHWAY BRIDGE TOOLS A 2

Name _____ Score _____

OBJECTIVE 1

Given a list of terms associated with highway bridge construction tools, match them to their correct definitions. Write the letter that corresponds to the most correct answer.

_____ 1. Which term describes a safety device used to push material through cutters to protect fingers?

a. Miter box
b. Finger stick
c. Dovetail
d. Push stick

_____ 2. On an electric tool, the rotating shaft or bar that holds cutting tools is a/an

a. hone
b. arbor
c. kerf
d. clamp rod

_____ 3. The powder load used to project fasteners in powder-actuated tools is called a/an

a. booster
b. shell
c. load
d. charge

_____ 4. A tool used to install pigtails is a

a. pigtail wrench
b. keel
c. stirrup
d. tying tool

May be photocopied for student use.

votech

_____ 5. Soft stone used as a marker is known as a

a. pencil
b. scribe
c. soapstone
d. stone pen

_____ 6. Which of these terms best describes the sharp, violent reaction of a tool as it rejects material being forced into it?

a. Jerk reaction
b. Back-burst
c. Kickback
d. Forced rejection

_____ 7. The fastener used with a powder-actuated tool is a

a. booster
b. power screw
c. dovetail
d. drive pin

_____ 8. An instrument used for marking and checking angles is called a

a. reeding bar
b. try square
c. miter box
d. fret

_____ 9. What is the term used to describe a cut in stock that keeps blades from binding?

a. Cut-back
b. Rabbet
c. Relief cut
d. Fret cut

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_____10. Which term best describes a device used to guide a saw at the proper angle for cutting material?

a. Miter box
b. Try miter
c. Bevel marker
d. Chamfer box

_____11. Special circuits used to protect workers from electrical shock are

a. transformers
b. flutes
c. AWS
d. GFCI

_____12. Exactly upright, at a right angle to another line or surface is known as being

a. level
b. straight
c. parallel
d. perpendicular

_____13. An electrical connection that provides an easy path for electricity to flow to the earth if a short occurs is a

a. flute
b. deadman
c. ground
d. conduit

_____14. A tool used to set and check for the vertical of a surface is a

a. plumb bob
b. framing square
c. keel
d. chalk box line

May be photocopied for student use.

_____15. The narrow groove produced by a saw blade is the

a. mortise
b. dovetail
c. kerf
d. arbor

OBJECTIVE 2

From alternatives, choose the proper care and safety guidelines for the use of hand and power tools.

_____ 1. When using power tools, you must *always* wear

a. a hard hat and steel-toed boots
b. steel-toed boots
c. eye protection and a hard hat
d. gloves and a hard hat

_____ 2. Do not use a power tool with the guards or _____ _____ removed.

a. safety devices
b. power charger
c. adaptor cable
d. optional accessories

_____ 3. Which of the following guidelines for power tool care are recommended?

a. Follow the manufacturer's maintenance procedures.
b. Protect cutting edges.
c. Keep tools in their proper place when not in use.
d. All of the above

_____ 4. Guards and safety devices

a. may be moved when necessary
b. must never be removed
c. should be kept clean and polished
d. should be replaced annually

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_____ 5. If you are going to operate a circular saw and your feet are wet,

a. stand on a nonconducting surface
b. remove your shoes
c. report an unsafe condition to your instructor
d. do not operate the saw

_____ 6. Machine surfaces should be cleaned and

a. oiled
b. waxed
c. buffed
d. free of marks

_____ 7. Power tools must not be left running while unattended, must be disconnected before performing maintenance or changing accessories, and must be

a. grounded
b. in warranty
c. no more than 3 years old
d. operating with at least 50% capability

_____ 8. The correct position for operating a power tool is

a. whatever is safe and comfortable
b. at eye level
c. feet apart and balanced
d. relaxed

_____ 9. The work area should

a. have everything in easy reach
b. be kept clean at all times
c. be cleaned before leaving the shop
d. be comfortable

_____10. Throwing a wrench to another worker is

a. considered horseplay
b. acceptable in some circumstances
c. cause for dismissal
d. unsafe

May be photocopied for student use.

_____11. Tools and accessories should be inspected

a. daily
b. weekly
c. monthly
d. regularly

_____12. Wear eye protection and a hard hat when

a. necessary
b. operating all tools
c. operating all power tools
d. operating tools that throw particles

_____13. Wear face protection when

a. necessary
b. required by the operator's manual
c. operating all power tools
d. operating all tools

_____14. When using electrical extension cords,

a. have no more than one tool on a cord
b. have no more than one tool on a circuit
c. use cords that are the right size for the tool
d. use cords no longer than 25 feet long

_____15. Who is wearing the MOST APPROPRIATE clothing?

a. Rick, who has his hair in a ponytail and wears sandals, stone-washed jeans and a T-shirt
b. Mary, who has her long hair down, and wears flats, a bulky sweater, and tights
c. Phil, who wears tight jeans, a cowboy shirt tucked into his pants, cowboy boots, and a bandanna tied loosely around his neck
d. Jennifer, who has short hair, and wears a tucked-in T-shirt, jeans, and boots

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OBJECTIVE 3

Given drawings, match ladders and scaffold types to their identities.

_____1. The type of ladder shown in the figure below is called a/an _____ ladder.

a. extension
b. step
c. single, straight
d. double, locking

May be photocopied for student use.

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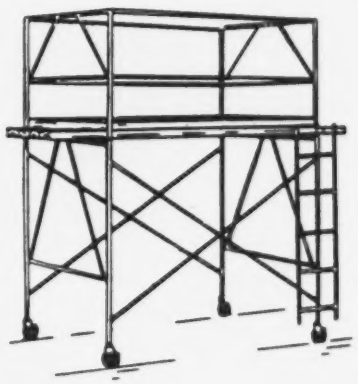
_____ 2. The type of scaffold shown in the figure below is called a _____ scaffold.



a. double pole
b. swinging
c. cylinder
d. prefabricated

May be photocopied for student use.

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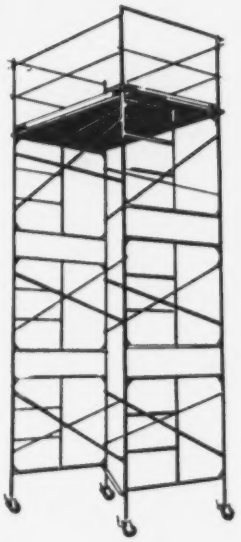
_____ 3. The scaffold type illustrated below is called a



a. double pole
b. single pole
c. scaffold jack w/platform
d. prefabricated

OBJECTIVE 4

Use an illustration to identify the parts of a scaffold.

_____ 1. What is the name of the scaffold part illustrated below?

a. Coupling pin
b. Framing member
c. Base plate
d. Crossbrace

May be photocopied for student use.

_____ 2. The illustration shown is known as a

a. base plate
b. rolling bracket
c. caster
d. wedge roller

_____ 3. What is the term that best describes the scaffold part shown below?

a. Screw jack
b. Base plate
c. Foot member
d. Caster

OBJECTIVE 5 **Choose from alternatives, the proper safety rules for the use of ladders and scaffolds.**

_____ 1. All scaffolds must be equipped with

a. top rail
b. midrail
c. toeboard
d. all the above

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votech

_____ 2. Before ascending a rolling scaffold be sure to *always*

a. remove the toeboard
b. install outriggers
c. lock the casters
d. all the above

_____ 3. Before using a ladder, you should consult the _____ to verify the highest working or standing level.

a. manufacturer's specifications
b. other workers
c. local building codes
d. consumer's guide

_____ 4. Metal ladders should never be used when

a. working above 16 feet
b. working weights are above 180 pounds
c. working near electrical conductors
d. using any kind of hand tool

_____ 5. Which of the following safety rules must be followed in using stepladders?

a. Never climb a ladder alone.
b. Fully spread and lock legs.
c. Climb and work from the top platform.
d. Remove safety shoes when working above 16 feet.

_____ 6. An extension ladder should extend a minimum of _____ feet above the top support.

a. 1
b. 2
c. 3
d. 4

May be photocopied for student use.

_____ 7. Scaffolds must be checked to ensure they are _____ before use.

a. level and plumb
b. equipped with a 12" high top rail
c. tied off when above four feet high
d. equipped with safety shoes

_____ 8. Workers should *not* ascend scaffolds

a. during periods of high wind
b. when covered with ice or snow
c. during storms
d. all of the above

_____ 9. When using a ladder, never carry _____ up a ladder.

a. bricks
b. lumber
c. siding
d. any load, including all the above

NOTE: Objectives 6-11 are evaluated on job sheets/assignment sheets in this unit. If you have not completed these components, see your instructor.

May be photocopied for student use.

WRITTEN TEST ANSWERS	HIGHWAY BRIDGE TOOLS			A 2
OBJECTIVE 1	1. d	6. c	11. d	
	2. b	7. d	12. d	
	3. a	8. b	13. c	
	4. d	9. c	14. a	
	5. c	10. a	15. c	
OBJECTIVE 2	1. c	6. b	11. d	
	2. a	7. a	12. c	
	3. d	8. a	13. a	
	4. b	9. b	14. c	
	5. d	10. d	15. d	
OBJECTIVE 3	1. a			
	2. d			
	3. d			
OBJECTIVE 4	1. a			
	2. c			
	3. a			
OBJECTIVE 5	1. d	4. c	7. a	
	2. c	5. b	8. d	
	3. a	6. c	9. d	

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) ***Introduction to Highway Bridge Construction***

UNIT NUMBER AND TITLE — **A 2 Highway Bridge Tools**

TOTAL NUMBER OF TEST QUESTIONS 45

TOTAL NUMBER OF BASIC SKILL QUESTIONS 0

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-15	X
2	1-15	X
3	1-3	X
4	1-3	X
5	1-9	X
6-11	Evaluated on AS/JS	

OBJECTIVE SHEET	APPLIED SKILLS	A 3

INTRODUCTION

The construction of highway bridges requires many skills. This unit will provide an introduction to the most common skills and improve your abilities through the completion of practical exercises.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVES

After completing this unit, the student will be able to identify bridge types and construct highway bridge forms. The student will demonstrate these competencies by completing the assignment sheet, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to show the ability to:

1. Given a list of terms associated with highway bridge construction, match them to their definitions.
2. Given drawings, identify common highway bridges types.
3. Given an illustration, identify types of bridges that use reinforced concrete slabs.
4. Given choices, select the correct rules to install concrete reinforcing.
5. Install reinforcing bars for a footing. (Job Sheet 1)
6. Construct and strip forms for a square column. (Job Sheet 2)

SUGGESTED ACTIVITIES	APPLIED SKILLS A 3
PREPARATION	• Review unit and plan presentation. • Order or obtain materials to supplement unit. • Introduce unit.
DELIVERY	**Objective 1: Given a list of terms associated with highway bridge construction, match them to their definitions.** • Use the Information Sheets to introduce students to the terms and definitions associated with highway bridge construction. • Point out the importance of understanding the terms and definitions and how knowing them will help students to better understand this unit. **Objective 2: Given drawings, identify common highway bridge types.** • Use Transparency 1 to illustrate your discussion. • Make a bulletin board of pictures of photos of different types of bridges and bridge deck forms. • Ask students to provide the names of famous bridges and identify their types. **Objective 3: Given an illustration, identify types of bridges that use reinforced concrete slabs.** • Take the students on a tour of bridges in the community. Have students analyze the types of forms that were used and determine whether the bridge is constructed with a reinforced concrete slab. **Objective 4: Given choices, select the correct rules to install concrete reinforcing.** • Invite a reinforcing installer to the class to discuss basic skills and jobs with the students.

- Use the Information Sheets to describe the rules to install concrete reinforcing.

APPLICATION

Objective 5: Install reinforcing bars for a footing. (Job Sheet 1)
Objective 7: Construct and strip forms for a square column. (Job Sheet 2)

- Allow students to practice the procedures in the job sheets.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.

- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Complete appropriate sections of competency profiles.

- Reteach and retest if necessary.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Electronic Media

Available from AGC of America, 1957 E. Street N.W., Washington, DC 20006 or from the Oklahoma Department of Vocational and Technical Education.

- *Pave Your Way to Safety: Concrete Paving Safety*
- *A Safe Span: Bridge Construction Safety*
- *Vertical Piers and Columns*
- *Footing Forms*

All are available in VHS video form.

UNIT REFERENCES

- *Bridge Form Catalog*, Economy Forms Corporation, Box D, East 14th Street Station, Des Moines, IA 50316.
- Toenjes, Leonard P. *Building Trades Dictionary*, American Technical Publishers, Inc., Homewood, IL. 1989.
- Willey, Al. *Commercial Carpentry*. Oklahoma Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America: Stillwater, OK, 1993.

OBJECTIVE 1

Given a list of terms associated with highway bridge construction, match them to their definitions.

- **bridge** — structure erected over a depression or stream, as over a highway, chasm, or river, to provide a passageway for vehicles or pedestrians
- **bridge deck** — pavement surface on a bridge
- **compaction** — reducing the volume of soil or other material by compressing, vibrating, or tamping to eliminate voids
- **crown** — the center of a roadway that is slightly elevated to promote water drainage
- **dead weight** — the weight of all the structural elements and fixtures of a bridge
- **grade** — the elevation of earth, form elements, or bridge structure at a job site
- **live weight** — the weight of all traffic expected to pass over a bridge at any given point in time
- **mat** — gridwork of rebars
- **pavement profile** — the variation in elevation of the finished bridge deck surface
- **slab** — a layer of concrete
- **slope** — incline or pitch
- **stakes** — in highway bridge construction stakes are used to mark the

  a. slope

  b. shoulders

  c. grades

d. centerline

NOTE: Centerline stakes have blue tips or flags attached to them.

- **traffic control** — the process of safely routing traffic around a highway bridge construction site

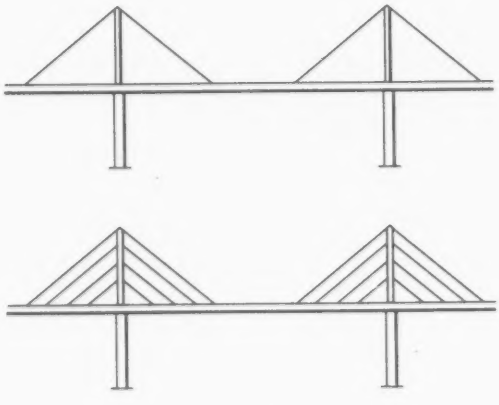
OBJECTIVE 2 **Given drawings, identify common highway bridge types.**

- Arches

FIGURE 1

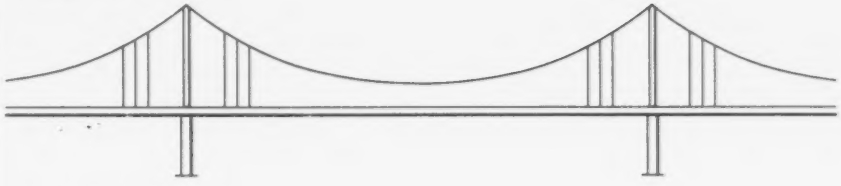
- Cable-stayed

FIGURE 2



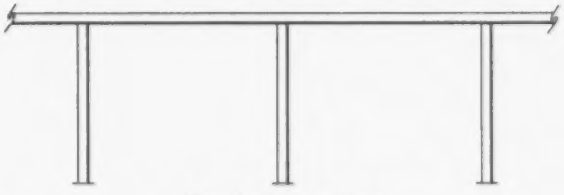
- Suspension

FIGURE 3

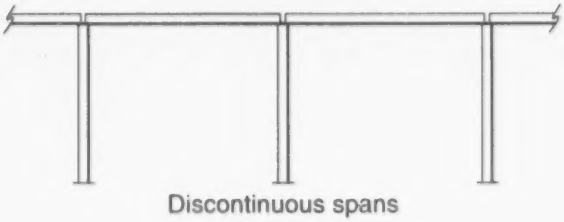


- Grider

FIGURE 4



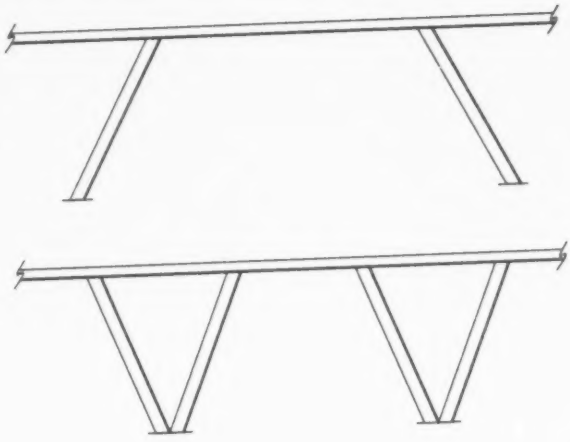
Continuous spans



Discontinuous spans

- Rigid frame

FIGURE 5

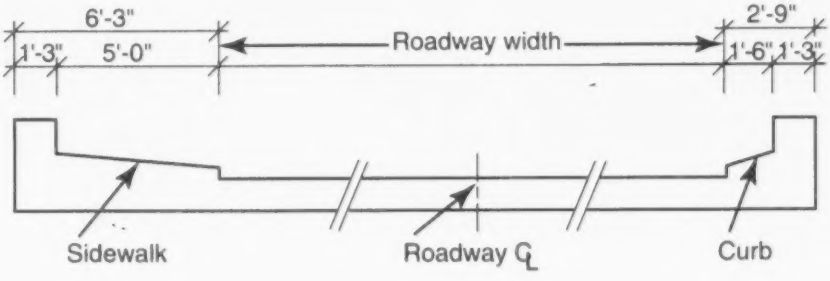


OBJECTIVE 3

Given an illustration, identify types of bridges that use reinforced concrete slabs.

1. Profile of a reinforced concrete slab

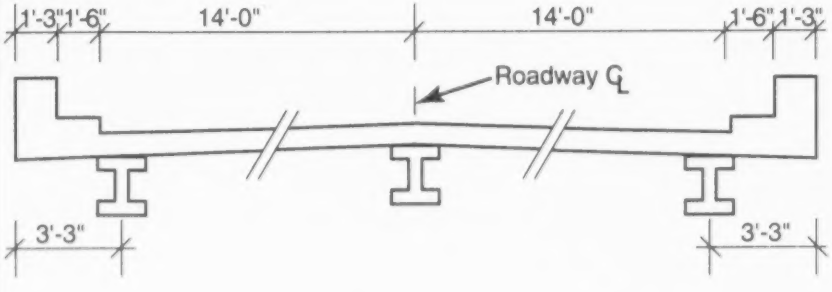
FIGURE 6



NOTE: The "CL" specifies the centerline or crown of the roadway.

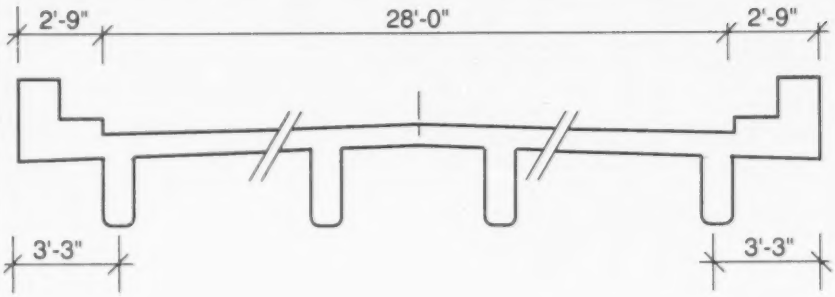
2. Profile of a steel I-beam

FIGURE 7



3. Profile of a reinforced concrete T-beam

FIGURE 8



NOTE: The application of concrete slab bridge decks are based largely on the bridge design, its span, and the live weight it is required to support.

OBJECTIVE 4

Given choices, select the correct rules to install concrete reinforcing.

- General rules to follow when using steel reinforcing
  - — Use clean steel free from oil, dust, paint, and scale.
  - — Place steel as determined by building code, plans, or specifications.
  - — Typically, lap bars 20 times their diameter and never less than 15 inches or according to specifications.
  - — Butt weld bars according to specifications.
  - — Place reinforcing primarily where the concrete will be in tension and shear forces exist.
  - — Tie reinforcing solidly so that it cannot shift when concrete is placed.
  - — Never use incorrectly marked rebar.

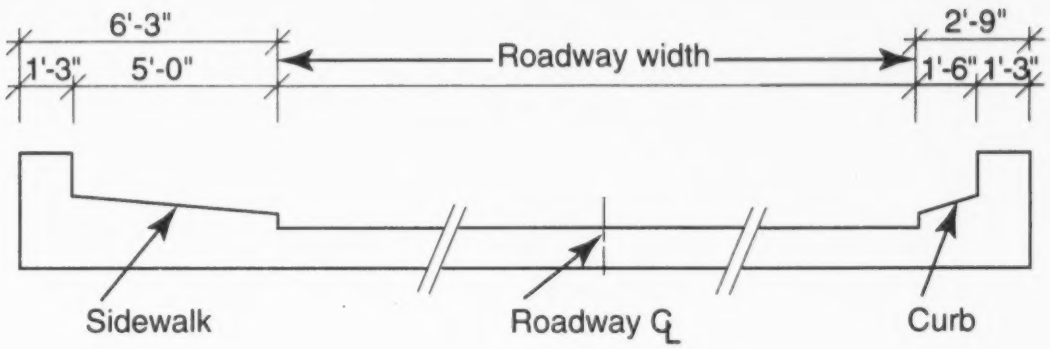
— Place rebar caps over any protruding rebar ends as a safety precaution.

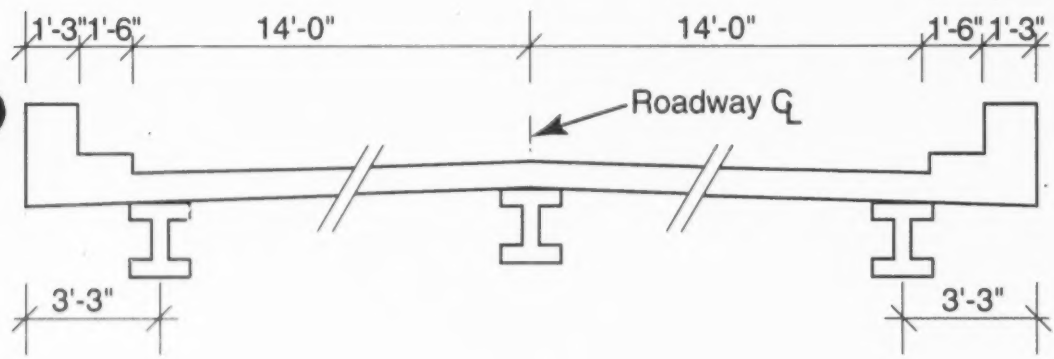
— Steel reinforcement must be placed with a specified concrete coverage. Carefully review plans to ensure reinforcement is not placed too near concrete edges or surfaces.

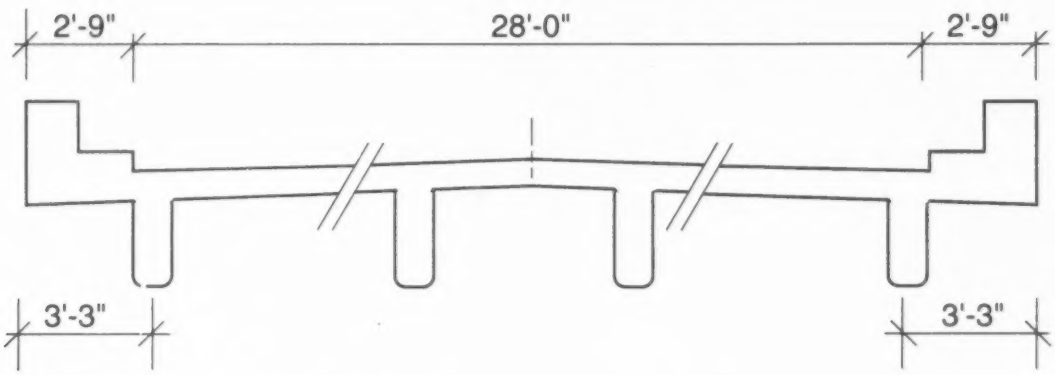
— Always apply form oil before installing reinforcing.

NOTE: When tieing epoxy coated rebar, use epoxy coated tiewires.

Types of Bridges That Use Reinforced Concrete Slabs







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JOB SHEET 1	APPLIED SKILLS	A 3

OBJECTIVE 5

Install reinforcing bars for a footing.

INTRODUCTION

This exercise will give you practice in the layout and installation of rebar for a 6′ 9″ footing. The mat will require #4 rebar placed at 12 O.C.

EQUIPMENT AND SUPPLIES

- Eye protection and hard hat
- Side cutters, one pair
- Folding rule or tape
- Soapstone
- Wire reel and tie wire
- Twelve #4 rebars 5′-6″ long
- Twelve bricks or pieces of concrete bricks, chairs, or bolsters as per specifications

PROCEDURE

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

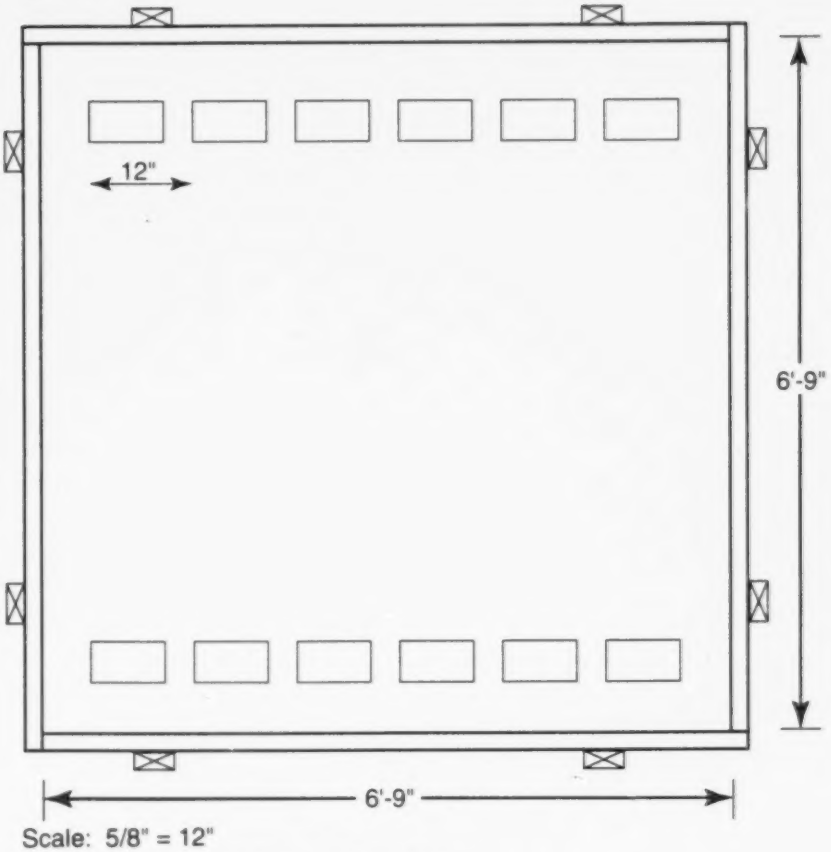
General Science
- Use scientific instruments

		Yes	No
1.	Put on eye protection, gloves, and hard hat.	___	___

Yes No

2. Place six bricks, chairs, or bolsters flat on bottom of slab as shown below approximately twelve inches apart to support the rebar. (Figure 9) ___ ___

FIGURE 9



Scale: 5/8" = 12"

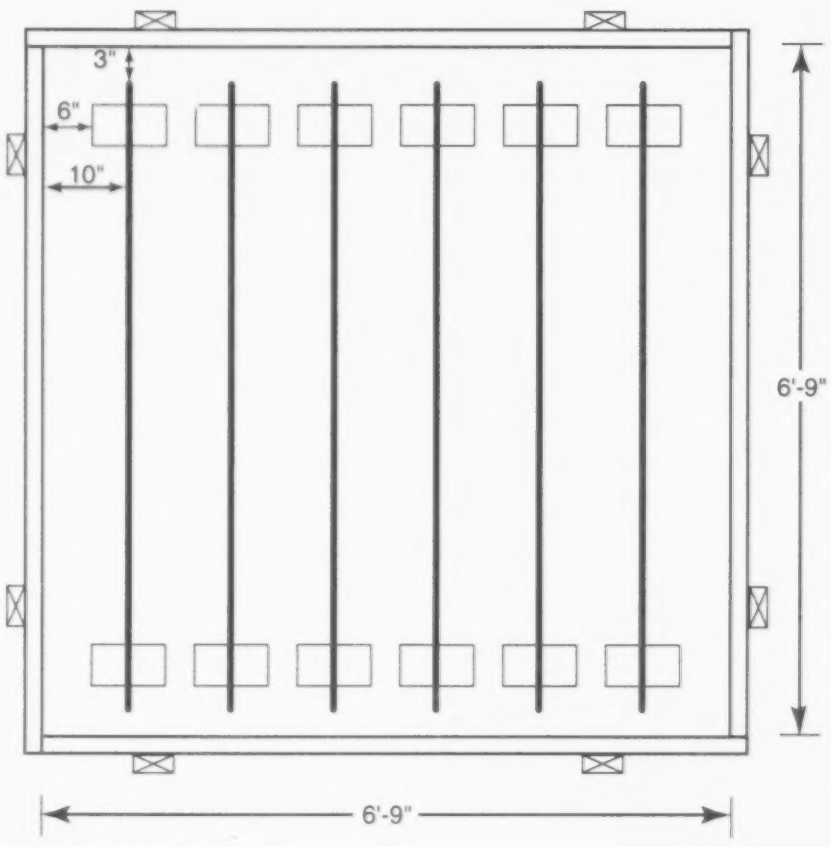
3. The first bricks should be positioned 6" from the form sides. (Figure 10) ___ ___

Yes No

4. Place six rods across the bricks, laying rods as shown below, with the two outside rods ten inches in from the edge of the footing; using keel and rule, place marks on two outside rods twelve inches apart, starting three inches from end. ___ ___

   NOTE: When installing rods against earth a three inch clearance between end of rod and earth is required.

FIGURE 10

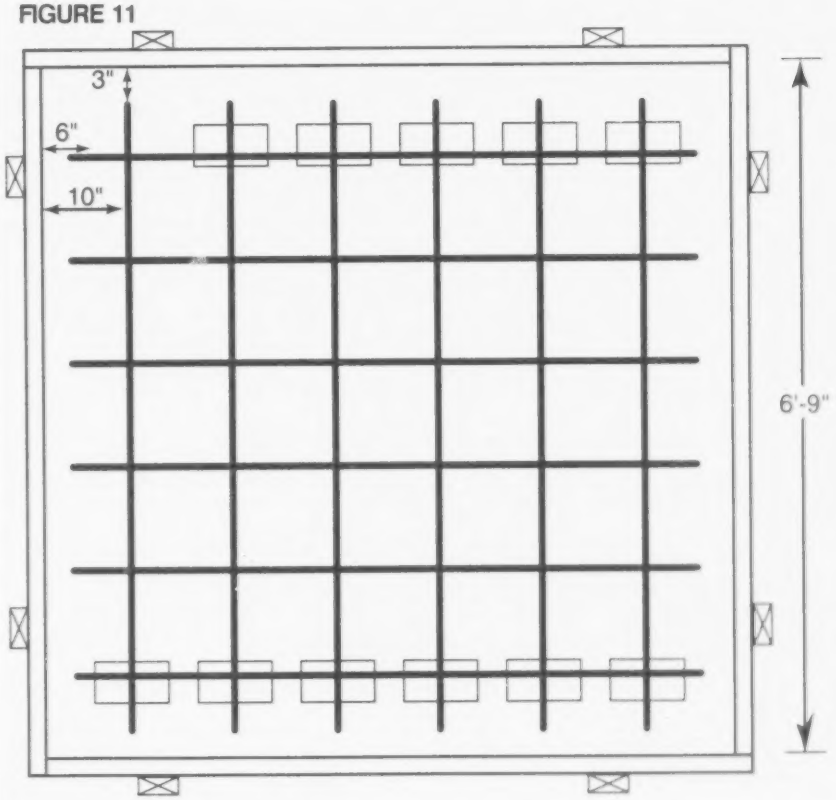


Scale: 5/8" = 12"

Yes No

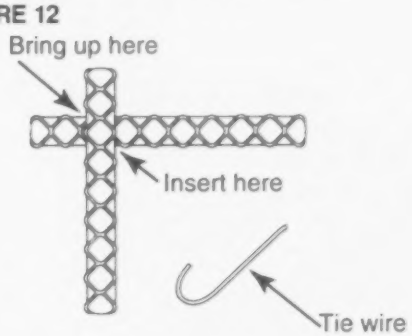
5. Place remaining six rods across other six rods aligning them with the twelve-inch marks. ___ ___

FIGURE 11



6. Pull a small amount of wire from reel and put small hook in the end of tie wire; insert wire down and under the two rods so that end will come up on opposite side. ___ ___

FIGURE 12



Yes No

7. Hold wire; grasp both sections with side cutters and twist. ___ ___

FIGURE 13

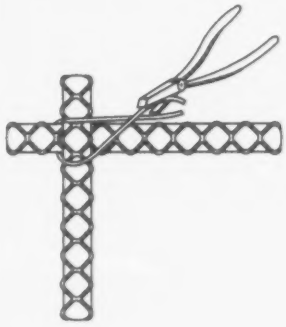
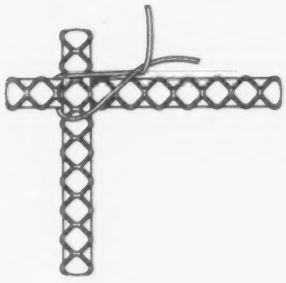
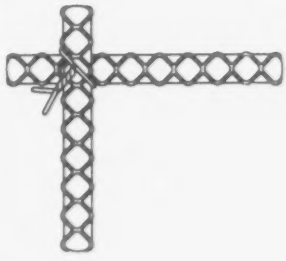


FIGURE 14



8. Make about three or four twists; cut both wires so there will be approximately three-quarters of an inch left; then tap these ends down with side cutters. ___ ___

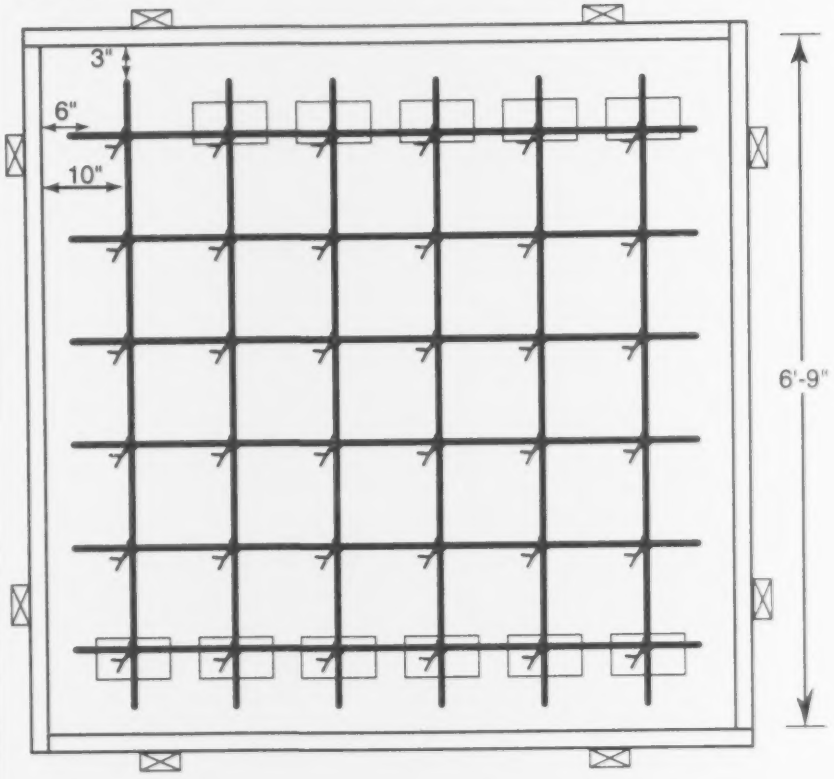
FIGURE 15



Yes No

9. Continue this operation until entire reinforcing mat has been tied together. ___ ___

FIGURE 16



NOTE: Steel mats in small footings are usually preassembled and then placed after forms are set.

10. This concludes this Job Sheet. Ask your instructor to evaluate your work. ___ ___

11. Clean up the area and put away all tools and materials. ___ ___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Rebar supports set properly (+/- ½")	4	3	2	1
Rebar set from edges and ends (+/- ¼")	4	3	2	1
Bars aligned at 12" mark (+/-¼")	4	3	2	1
Wire ties secured (¼")	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 2	APPLIED SKILLS	A 3

OBJECTIVE 6

Construct and strip forms for a square column.

INTRODUCTION

This exercise provides the student with practice in building and stripping forms for a square column. Both job-built and patented forms are discussed.

EQUIPMENT AND SUPPLIES

- Goggles and hard hat
- Hammer
- Handsaw
- Circular saw and extension cord
- String line
- Electric drill and bits
- Hand level, 30″
- Framing square
- Chalk line
- Folding rule or steel tape
- Pry bar
- Sheathing plywood
- 2×4s for studs and template
- Appropriate column clamps
- Form oil and mop, brush, or sprayer
- 6d duplex, 16d duplex, and concrete nails or powder-actuated fastener

PROCEDURE

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols

		Yes	No
1.	Use building plan to determine size of column.	___	___
2.	Put on safety equipment.	___	___

Math
Application Skills
- Use English and metric measures

Data Analysis
and Display
- Interpret charts and tables
- Interpret plans/ blueprints

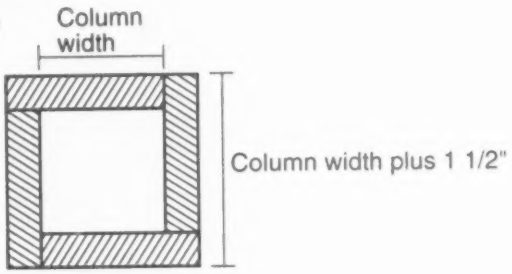
Functional
Math Skills
- Make measurements

General
Science Skills
- Use scientific instruments

Job Acquisition/
Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
3. Cut column sides (plywood sheathing) to size. (Figure 17)	___	___

FIGURE 17



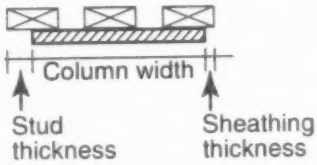
4. Cut column studs.	___	___

NOTE: Studs will be the same length as the column side.

5. Assemble column sides. (Figures 18)	___	___

FIGURE 18

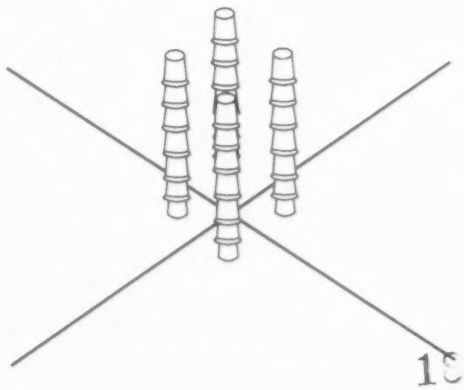
FOUR THUS FOR EACH COLUMN



6. Lay out column center lines. (Figure 19)	___	___

NOTE: Extend lines so they will show on outside of column forms and template.

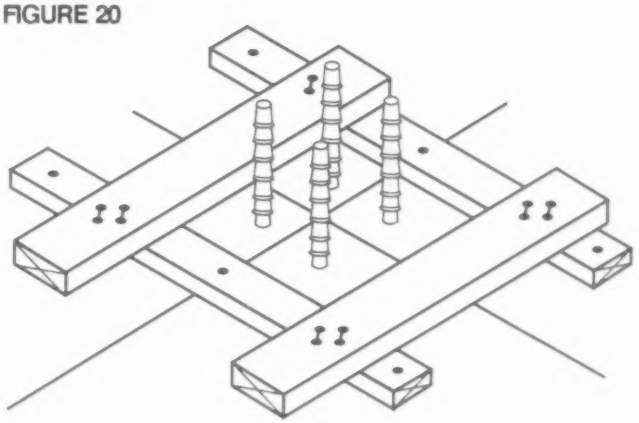
FIGURE 19



	Yes	No
7. Construct template for base of column. **NOTE:** Template should be the same size as the outside of the column form.	___	___
8. Use concrete nails or powder-actuated fastener to nail template to floor. (Figure 20) As an alternate method, drill a pilot hole and pin the template with nails. This will prevent the concrete from spalling.	___	___

CAUTION: Use powder-actuated fastener only if certified in its use. Follow manufacturer's instructions and safety precautions before loading or operation.

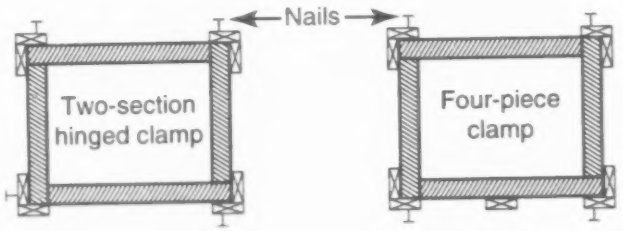
FIGURE 20



9. Refer to column clamp manufacturer for proper clamp spacing.	___	___

	Yes	No
10. Lay out column clamp spacing on form sides.	___	___
NOTE: All steel must be completely in place and forms should be covered with form oil.		
11. Stand opposing column sides in template and nail corner studs with duplex nails.	___	___
12. Stand the other two sides in template and nail as in step 11.	___	___
13. Drive 16d duplex nail at each column clamp spacing mark. (Figure 21)	___	___
NOTE: These nails serve to support the clamps during installation. Check the type of clamp being used for side locations of nails.		

FIGURE 21



14. Lay sections of column clamps on nails and secure together.	___	___
15. Install braces for columns.		
a. Nail braces to two sides of column near top of column.	___	___

		Yes	No
	b. Nail block in position to floor so that lower end of brace can be nailed to block.	___	___
16.	Plumb column in both directions and then nail bracing to blocks on floor. **NOTE:** When several columns are set in a straight line, alignment is made by running a pair of stringers at the top of the columns from one column to the next. One brace is needed to plumb the column on the opposite side.	___	___
17.	Recheck work for plumb and accuracy.	___	___
18.	Patented forms reduce the effort of form construction through prefabrication of form components. Their on-site assembly is similar to that of job built forms with the exception of cutting form material.	___	___
19.	Ask your instructor to evaluate your form.	___	___
20.	Disassemble the form in the reverse order of its construction.	___	___
21.	This concludes the job sheet for the construction of a square column. Consult with your instructor for the need to apply form oil.	___	___
22.	Clean work area and return equipment and materials to proper storage.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

_____

_____

_____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Safety equipment used properly	4	3	2	1
Plumb (¼")	4	3	2	1
Square clamp spacing proper	4	3	2	1
Braces secure	4	3	2	1
Form dimensions correct (⅛")	4	3	2	1

EVALUATOR'S COMMENTS

_____

_____

_____

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

WRITTEN TEST	APPLIED SKILLS	A 3

Name _____ Score _____

OBJECTIVE 1

Given a list of terms associated with highway bridge construction, match them to their definitions. Write the letter that corresponds to the most correct answer.

_____ 1. The process of safely routing traffic around a highway bridge construction site is

a. detour processing
b. traffic control
c. diversion processing
d. routing plan

_____ 2. The weight of all the structural elements and fixtures of a bridge is called its

a. dead weight
b. live weight
c. load limit
d. volume capacity

_____ 3. The pavement surface on a bridge is a

a. bridge deck
b. bridge cap
c. steel framework
d. surface layer

_____ 4. Stakes are used to mark the

a. slope
b. grade
c. centerline
d. all the above

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_____ 5. At a bridge construction site, the term "mat" can be used to describe a

a. layer of fill material
b. gridwork of rebar
c. both a and b are correct
d. slab of concrete

_____ 6. An incline or pitch is called the

a. density
b. grade
c. crown
d. slope

_____ 7. The center of a roadway that is slightly elevated to promote water drainage is a

a. ridge
b. crown
c. mat
d. shoulder

_____ 8. The elevation of earth, form elements, or a bridge structure is its

a. grade
b. height
c. pitch
d. slope

_____ 9. A layer of concrete is a

a. mat
b. slab
c. pavement mat
d. decking mat

_____10. The variations in elevation of the finished bridge deck surface is a

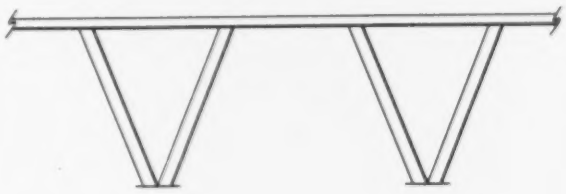
a. density plan
b. pitch sequence
c. pavement profile
d. contour map

May be photocopied for student use.

OBJECTIVE 2

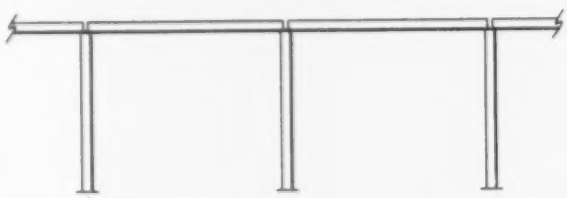
Given drawings, identify common highway bridge types.

_____ 1. The type of highway bridge shown below is a



a. grider
b. rigid
c. suspension
d. both a and b are correct

_____ 2. The type of bridge shown below is a



a. overhead span
b. continuous span grider
c. discontinuous span grider
d. suspension

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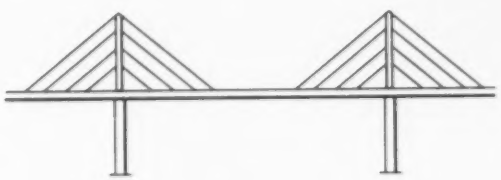
_____ 3. The type of bridge illustrated below represents a

a. cable arch
b. arch
c. suspension
d. all the above

_____ 4. The type of bridge shown in the drawing below is classed as a



a. cable-stayed
b. overhead suspension
c. pyramid swing
d. grider

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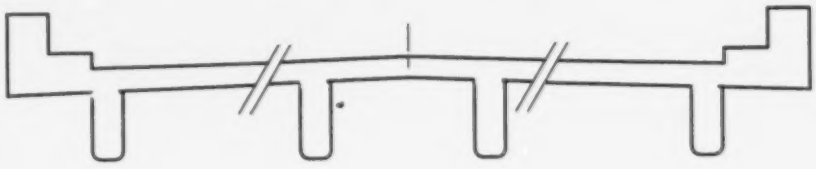
OBJECTIVE 3

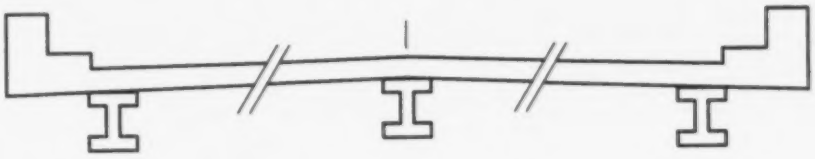
Given an illustration, identify types of bridges that use reinforced concrete slabs.

_____ 1. The type of bridge illustrated below is a



a. encased I beam
b. reinforced concrete T-beam
c. oversize T-beam
d. non-reinforced slab

_____ 2. This type of bridge is a



a. reinforced concrete I-beam
b. steel T-beam
c. angle beam deck
d. steel I-beam

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OBJECTIVE 4

Given choices, select the correct rules to install concrete reinforcing.

_____ 1. Safety rules require that

a. bars can *not* be overlapped more than 12 inches
b. rebar caps be placed over any protruding bars
c. incorrectly marked rebars be used
d. reinforcing be tied loosely to allow bars to shift

_____ 2. Rebars should never be lapped less than

a. 48″
b. 24″
c. 15″
d. 6″

_____ 3. Steel must be placed

a. according to specifications
b. based on personal preference
c. only in slab floors
d. anywhere you feel there is a need

_____ 4. Reinforcing steel must be

a. tied loosely
b. clean-free of oil, dust, paint, or scale
c. installed to touch forms
d. coated with form oil before concrete is placed

_____ 5. Steel reinforcement must be placed to

a. touch the edge of forms
b. be overlapped not more than 6″
c. allow it to shift during concrete placement
d. meet the plan for concrete coverage

NOTE: Objectives 5 and 6 are evaluated on job sheets in this unit. If you have not completed these components, see your instructor.

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WRITTEN TEST ANSWERS	APPLIED SKILLS	A 3

OBJECTIVE 1

1.	b	6.	d
2.	a	7.	b
3.	a	8.	a
4.	d	9.	b
5.	b	10.	c

OBJECTIVE 2

1.	b	3.	b
2.	c	4.	a

OBJECTIVE 3

1. b
2. d

OBJECTIVE 4

1.	b	4.	b
2.	c	5.	d
3.	a		

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) ***Introduction to Highway Bridge Construction***

UNIT NUMBER AND TITLE – **A 3 Applied Skills**

TOTAL NUMBER OF TEST QUESTIONS 21

TOTAL NUMBER OF BASIC SKILL QUESTIONS 0

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-10	X
2	1-4	X
3	1-2	X
4	1-5	X
5-6	Evaluated on JS	

INTRODUCTION TO HIGHWAY BRIDGE CONSTRUCTION
COMPETENCY PROFILE

Student _____ Soc. Sec. No. ___ – ___ – ____
Last First MI

PROGRAM Grade 9 10 11 12 Adult SCHOOL

INSTRUCTOR SCHOOL ADDRESS PHONE

STUDENT'S HOME ADDRESS DATE OF BIRTH PHONE

STUDENT'S EMPLOYER ADDRESS PHONE

CONTACT IN CASE OF EMERGENCY PHONE

ADDRESS

ADDRESS PHONE

The above information can be used for school records and/or to ensure safety of students. This confidential information is not to be released to employers or to the general public.

ON-THE-JOB TRAINING/WORK EXPERIENCE

DURATION OF EMPLOYMENT	JOB TITLE	EMPLOYER	SUPERVISOR'S NAME	ADDRESS OF EMPLOYER	PHONE

This agency does not discriminate on the basis of race, creed, color, national origin, sex, age, veteran status, qualified handicap, or disability.

Duplicate one copy for each student.

SPECIFIC JOB COMPETENCIES

DIRECTIONS: Evaluate the trainee using the rating scale below, and check the appropriate number to indicate the degree of competency. The numerical ratings of 4, 3, 2, 1, and 0 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on level of student performance for each of the tasks listed below.

Rating Scale:
- **4 — Skilled** — can perform job independently with no additional training.
- **3 — Moderately Skilled** — has performed job independently during the training program; limited additional training may be required.
- **2 — Limited Practice** — has practiced job during training program; additional training is required to develop skill.
- **1 — Exposure Only** — general information provided with no practice time; close supervision needed and additional training required.
- **0 — No Exposure** — no information or practice provided during training program; complete training required.

UNIT A1

4	3	2	1	0

Highway Bridge Materials

1. Given a list of terms associated with highway bridge materials, match them to their correct definitions.
2. Given a list of terms associated with concrete materials, match them to their correct definitions.
3. Name common types and shapes of structural steel used in modern highway bridges.
4. Interpret reinforcing bar size markings.
5. Given illustrations, identify hardware accessories used to install reinforcing bars.
6. Given illustrations, identify parts of the common types of concrete forms used to construct highway bridges.
7. _____

WRITTEN TEST SCORE _____

UNIT A2

4	3	2	1	0

Highway Bridge Tools

1. Given a list of terms associated with highway bridge construction tools, match them to their correct definitions.
2. From alternatives, choose the proper care and safety guidelines for the use of hand and power tools.
3. Given drawings, match ladders and scaffold types to their identities.
4. Use an illustration to identify the parts of a scaffold.
5. Choose from alternatives, the proper safety rules for the use of ladders and scaffolds.
6. Given drawings, identify hand tools used for the construction of highway bridges.
7. Given drawings, identify power tools and equipment used for the construction of highway bridges.
8. Use a hammer properly.
9. Use a handsaw.
10. Use a level.
11. Perform a crosscut using a radial arm saw.
12. _____

WRITTEN TEST SCORE _____

UNIT A3

4	3	2	1	0

Applied Skills

1. Given a list of terms associated with highway bridge construction, match them to their definitions.
2. Given drawings, identify common highway bridges types.
3. Given an illustration, identify types of bridges that use reinforced concrete slabs.
4. Given choices, select the correct rules to install concrete reinforcing.
5. Install reinforcing bars for a footing.
6. Construct and strip forms for a square column.
7. _____

WRITTEN TEST SCORE _____

Use of This Document

Use of this document can be used to record information about the student and the skills mastered by the student. This information is useful in documenting student progress during the training program and to provide information about the student's qualifications to potential employers and for entry into advanced training programs. Instructors using AGC-CIMC instructional materials are authorized to reproduce this document as required for use in their training programs.

INTRO. TO HIGHWAY BRIDGE CONSTRUCTION

CIMC

READING SKILLS

UNITS OF INSTRUCTION	Reading Comprehension								Research and Reference								Functional Reading						Language		Composition					
	Gain factual information	Distinguish fact, opinion and inference	Recognize stereotyping and bias	Recognize propaganda	Analyze cause and effect	Draw conclusions	Make generalizations	React to written material	Apply word analysis techniques	Select useful resources	Locate resources	Find materials in library	Use standard references	Use in-book reference tools	Use audiovisual media	Use computer data base	Use magazines and newspapers	Interpret forms and records	Follow written instructions	Interpret graphics and symbols	Use content area vocabulary	Interpret abbreviations/acronyms	Read aloud	Use standard grammar and correct spelling, punctuation, and capitalization	State ideas clearly	Use complete sentences	Develop preliminary outline	Use topic sentences	Use introductory/closing paragraphs	Compose reports	Compose essays	Proofread and edit
Highway Bridge Materials																														
Highway Bridge Tools and Equipment																														
Applied Skills																		●	●	●										
																		●	●	●										

CIMC BASIC SKILLS DOCUMENTATION

WRITING SKILLS

MATH SKILLS

Composition			Research			Functional Writing									Operation and Calculation												Math Application												Data Analysis and Display						
Use introductory/closing paragraphs	Compose reports	Compose essays	Proofread and edit	Construct graphics and symbols	Take notes	Use notecards	Create bibliography	Use footnotes	Outline material	Complete forms and records	Write instructions	Write letters	Write job applications	Write resumes	Use word processing	Use computer graphics	Round off numbers	Estimate answers	Use scientific notations	Use exponential notations	Calculate with whole numbers	Calculate with fractions	Calculate with decimals	Convert whole numbers to fractions	Convert whole numbers to decimals	Solve numerical expressions	Solve formulae and equations	Obtain squares and square roots	Convert units of measure	Perform metric calculations	Solve word problems	Select/apply mathematical formula	Select/apply mathematical procedure	Use English and metric measures	Solve time/rate/distance problems	Solve ratio/proportion problems	Solve percent problems	Apply techniques of scaling	Apply algebra principles	Apply geometry principles	Apply trigonometry principles	Interpret charts and tables	Interpret graphs (type)	Collect /record data	Apply sampling techniques	Apply principles of probability	Construct charts and tables	Construct graphs	Calculate statistics
										•																								•	•							•	•						

ON MATRIX

ILLS

SCIENCE SKILLS

Analysis/ Display						Functional Math										General Science									Life Science									Physical Science									Earth Science								
Apply principles of probability	Construct charts and tables	Construct graphs	Calculate statistics	Interpret statistics	Interpret blueprints/plans	Make measurements	Perform banking transactions	Make change	Solve practical problems	Calculate gross earnings	Solve income/expense problems	Prepare a budget	Calculate interest	Solve interest problems	Calculate sales tax	Determine income tax	Use calculator for computation	Use computer for computation	Use computer spreadsheets	Apply computing skills	Apply scientific method of inquiry	Conduct experiments	Investigate science ethics	Investigate science history	Investigate/apply economics in technology	Use scientific instruments	Investigate/apply technology	Collect specimens	Identify/classify living organisms	Investigate biological history of the earth	Investigate food chains, webs, pyramids	Investigate/apply principles of human development	Investigate/apply principles of genetics/heredity	Investigate/apply principles of anatomy/physiology	Investigate health issues	Analyze/classify matter	Investigate forms/changes of matter	Investigate forms/changes of energy	Investigate/apply chemical properties	Investigate/apply physical laws	Investigate physical characteristics of the earth	Investigate geological history of the earth	Investigate physical forces acting on the earth	Solve problems of longitude, latitude, and time zones	Investigate conservation of physical resources	Investigate conservation of living resources	Investigate issues of environmental impact	Apply science principles to environmental issues
					•	•																				•																							

CIMC

ORAL COMMUNICATION SKILLS

INTERP

	Oral Presentation								Listening			Interactive Communication								General Relating										
UNITS OF INSTRUCTION	Make informative presentations	Make persuasive presentations	Present personal opinion/viewpoint	Use good speaking techniques	Select/use words effectively	Use effective body language	Present approriate appearance	Integrate audio and/or visual materials in oral presentations	Adapt presentation to specific audience	Apply active listening skills	Distinguish fact, opinion, and inference	Draw conclusions/make generalizations	Analyze/identify point of view	Give/follow oral directions	Apply questioning techniques	Conduct/receive interviews	Analyze/apply nonverbal communication	Work effectively in a group	Communicate with clients/customers/patients	Communicate with co-workers	Communicate with supervisors	Communicate with professional colleagues/associates	Apply telephone etiquette	Investigate/apply communication process models	Analyze/apply nonverbal communication	Investigate/apply cross-cultural communication	Interact with co-workers	Interact with supervisors	Interact with clients/customers/patients	Interact with professionalcolleagues/associates	Interact with family/friends	Participate in group activities	Participate in industrial relations/functions	Identify personal values/attitudes	Apply information to life experiences	Identify values/attitudes	Identify needs/drives
Highway Bridge Materials																													
Highway Bridge Tools and Equpment																													
Applied Skills																													

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RPERSONAL OR RELATING SKILLS

CREATIVE THINKING/ PROBLEM SOLVING SKILLS

EMPLOYA

Teamwork Cooperation												Leadership Influence							Cognitive Activities																Job Search Selection											
Identify needs/drives	Select/apply appropriate behavior	Investigate/identify personal styles	Investigate/identify group/corporate climate	Give/receive feedback	Identify hidden purposes	Investigate/apply group dynamics	Control undesirable/inappropriate behavior	Resolve conflicts	Clarify goals/objectives	Devise "win/win" situations	Build consensus	Generate ideas	Present point of view	Analyze/apply leadership styles	Analyze/apply management styles	Obtain confidence of others	Develop esteem in self/others	Persuade others	Analyze/apply motivation techniques	Provide positive coaching	Collect/record information	Identify critical elements/issues	Define a problem	Identify underlying causes	Apply a problem-solving model	Analyze/synthesize information	Identify/analyze underlying assumptions	Draw conclusions	Predict results/outcomes	Identify/evaluate consequences	Identify/develop alternatives	Evaluate alternatives	Select an alternative	Devise a solution	Create a finished product	Apply intuitive/creative thinking processes	Transfer knowledge/training to new situations	Apply new technology	Develop an action plan	Evaluate results/outcomes	Analyze personal occupational aptitudes/preferences	Investigate employment prospects of a career field/occupation	Investigate training requirements for a career field/occupation	Investigate benefits of a career field/occupation	Compare/evaluate career options	Develop personal career path	Locate appropriate jobs	Analyze duties/requirements/benefits of specific job	Master specific job task/procedure	Fill in job-related applications

...OYABILITY SKILLS

SOCIAL STUDIES SKILLS

| Job Aquisition Development | | |